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THE WORLD'S FAIR AND INDUSTRIAL ART.

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President of the Centennial International Exhibition of 1876.

THE influences of the International Exhibition of 1876 were so many and so wide-spread that it is practically impossible to trace them accurately in their many ramifications. To attempt it would require the services of numerous experts familiar each with special lines of industries or of art. No such exhaustive examination will be attempted in this paper, which shall be only a sketch of some of the more important results which to the writer appear to have followed the Centennial. The purpose of this retrospect is to emphasize some of the benefits that are likely to be derived from the World's Columbian Exhibition of this year. The possibilities of a great exhibition in its influence upon our people and our industries, especially upon those in which the arts are applied, are generally appreciated, though rather vaguely. One is apt to conclude from the articles in magazines and newspapers and from general conversation that the great interest of the fair is looked for in its entertaining features,—that it is to be primarily a show. Only in a restricted sense ought this idea to be encouraged; for the real purpose—indeed, the saving purpose—of international exhibitions is their educational, not their spectacular aspect; not the provision made for temporary entertainment and astonishment, but in the opportunities offered for the acquisition of ideas of practical application in the advancement of arts, industries, culture, or general welfare in any direction. In an address at Philadelphia I had occasion to refer to the utility of exhibitions as follows: "Nothing less than a lively and universal sense of their international and commercial

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benefits, and of their political, social, and educational effects, can account for the spontaneous coöperation of the active and leading minds of the world, and for the great and willing expenditures of time and money which they require."

While there are the two points of view from which to regard an exhibition,—namely, first as a show for the entertainment of visitors; second as an educational factor,—there can be no question as to the relative importance of these two aspects. Indeed, the show idea is to be seriously considered only so far as it facilitates the impression of an influence toward education. This is the main reason for the support of exhibitions by European governments. The people are to be enabled to learn their own resources and powers, whether of invention, manufacture, or esthetic expression. The competition between home and foreign exhibitors discloses not only the strength, but, most important, the weakness of the home nation, and suggests the manner of overcoming the latter. It is in the learning of what we did not know that exhibitions are helpful, not so much as opportunities for the display of our actual achievements, except as comparison may reveal lines of progress. Naturally, we take just pride in demonstrating most forcibly our own accomplishments; and the great exhibitions have always facilitated this demonstration. Yet the real return to the people comes through the other channels, in which it finds itself outstripped by others, and in which it has thus afforded it the opportunity to see why, how, and how far it is behind. Without this we may have a great show, but not a great exhibition. The men in charge of the approaching Columbian Exhibition need not be reminded of this, but the public, if one may judge from the tone of current references to the exhibition, may well be reminded that it has serious lessons to learn in Chicago this year,—that it must go there not merely to be amused by a few days, or weeks, of lighthearted entertainment, but prepared for the closest observation, the most keen and diligent study—intelligent comparative study, which is far from easy—of the products of the peoples of the world, with a view solely to our own material, scientific, and esthetic advancement. The time will be short, the opportunities many.

It may help to impress this fact to look back at the Centennial Exhibition of 1876 and at some of its influences. Can you realize the change we have undergone in the sixteen years that have elapsed? In machinery, in all applied mechanics, our activity was vigorous, and in this direction our exhibit was most creditable;

in fact, so impressive was the showing of our natural resources, and so positive the evidence of our power in manufacture and commerce, that those six months sufficed to completely alter the attitude of the European mind toward us. From a provincial nation, one up to that time associated with the idea of colonies, we became at once to Europe a "great nation," with resources to be drawn upon by commercial conciliations, a nation to be reckoned with in the markets of the world. But, in culture was it not seriously otherwise? Were we not mortified by the realization of incomparable weakness? The liberal arts were manifested in the European and Oriental exhibits; not in ours. And we learned the lesson and set ourselves to applying it until now we must stand amazed by the penetration of esthetics into every nook and cranny of our lives. From the commonest domestic utensil to the most extravagant luxury the influence has extended. Since 1876 we have passed through many phases of experience, taking lessons now from English, now from Japanese, now from French or German products, which were first extensively shown us in Philadelphia. Select almost any manufacture. Take, by hazard, wall-papers. Compare the designs of to-day with those of 1876, as you recall them. Look at the hopeless furniture of 1876, debased beyond redemption from the purer types which had come over in colonial times. Then textile fabrics, ceramics,—including glass, in which American manufacturers have accomplished so much,—in fact, all the furnishings of your house from the attic to the cellar. Nor forget the outside of the house, where architects are constantly teaching us purer taste. See what this has led to in the exhibition buildings at Chicago, of which the harmonious grouping and the beauty and elaborate decoration exceed the standard set by Paris in 1889.

As we went to Philadelphia in 1876, we must go to Chicago in 1893 to learn. It can hardly be expected that so radical a change will result. Yet in 1875 we little dreamed of the shaking-up in store for us. To now indicate in what directions we are to seek inspiration would be folly. Each one must go to seek for himself that which rounds out his own accomplishment, that which contains the richest material for future working. There will be enough,—far more than can possibly be assimilated. That the stimulus we shall receive will be not unlike that in Philadelphia is assured. There is additional reason for this in the fact that the advances made since 1876 have put us on a better footing for future development. Nor is this true alone in the fine and the indus-

trial arts. It is similarly the case in other more utilitarian directions. Business organizations are far more compact and efficient, combinations of capital are readily made for the successful pursuit of schemes of a magnitude hitherto impracticable. In this respect our manufacturers, merchants, our capitalists in general, possess a capacity far beyond anything that existed in 1876. Then, too, our natural resources are better known and the means of utilizing them are more under command. Our problems now are rather to ascertain directions into which to promote activity than to secure financial support for the perfecting of plausible plans. This condition is peculiarly favorable to the quick adoption of any congenial ideas that may present themselves in Chicago.

It is difficult to recall with any distinctness the state of the arts in the United States prior to 1876. A few individuals here and there bought paintings or works of sculpture, for which they competed in auction rooms, or in the ateliers, with the wealthiest of European connoisseurs. But these collectors were few in number, and among them few bought from any real knowledge and appreciation of art, but rather because of fashion. If intelligent collectors were scarce, public museums were still more so, and accordingly the people had no opportunity to come in contact with good art. It must be remembered that the highly matured processes for satisfactorily reproducing in cheap form the great works of art, as they are now made known through the illustrated magazines and newspapers, were then comparatively crude. American wood-engraving as it is now and the various photo-mechanical processes have taken good art into homes in which it had never set foot before. Writing in 1877, Colonel George Ward Nichols, who was chairman of the group of judges on Fine Art at the Centennial, said: "Among us, as among older nations, there is a genuine taste for pictures, music, fine architecture, house-decoration, dress, ornamentation, landscape-gardening, rare books, and all objects which art has touched and beautified. This art culture is, however, individual rather than general. It is possessed by a considerable number of persons; but these rarely come together, and they assert little or no perceptible influence upon society. . . . We have attempted to put the machine in the place of the man. . . . The idea that art has any necessary relation to industry rarely enters into the mind of those most interested in the matter; our mechanics are too often workmen and not artisans. If this condition of things is not changed, we shall go on in our subservience to European art pro-

ducts and will never be able to gain any independence or individuality." These statements are still applicable, but not with the same force as fifteen years ago.

In the proceedings at the opening of the Museum of Fine Arts in Boston, on July 3, 1876, C. C. Perkins made an address this passage from which shows that he clearly foresaw the relation the International Exhibition of 1876 was to occupy to art culture: "It seems a good omen for the prosperity of the institution [the Boston museum] that it should date its real life from the Centennial year. . . . The coincidence is peculiarly felicitous, because a great exhibition is soon to be opened at Philadelphia, where the products of American civilization will be seen side by side with those of foreign nations. In many things we shall undoubtedly stand the comparison creditably; but in all that relates to art and the possible effects of art upon industry we cannot hope to compete with rivals whose advantages have been and are so much greater than our own. It is therefore fortunate that, by opening the doors of our Museum almost at the same moment with those of the Centennial Exhibition, we shall at least show that, having recognized the necessity, we have done our part towards providing those means for development in art of which this great country stands so much in need. . . . *The exhibition of 1876 may thus prove to be the source of that marked progress in art which, as we trust, is to date from this Centennial year.*

"Among the many desirable acquisitions brought within our reach by the Great Exhibition will be enamels, porcelain, and pottery from China and Japan, whose influence has been so marked upon modern industrial art; choice textiles from the East, whose unstudied beauty far surpasses the labored grace of like objects from western looms; and numberless objects sent from the great European States, which will show how great an influence has been exercised upon taste by those great industrial museums whose establishment is one of the most significant and remarkable features of the time in which we live."

The International Exhibition was, of course, not the sole influence directing our attention towards the arts. Indeed, the movement had in various cities throughout the country been started by far-seeing, public-spirited men and women. Art schools and art museums were being established, or were in contemplation. Yet, though this slow current had started, it was the Centennial, with its object lessons not to be evaded, that swelled it to a mighty stream.

Naturally the exhibits at the Centennial which were largest and most impressive affected us first, perhaps those in the English section first of all. We recall the wall-paper decorations, the Eastlake furniture, etc., which were adopted. Then the Japanese influence came almost simultaneously, though its fresh individuality made it less readily understood and assimilated. And, of course, France, as the established arbiter of fashion, affected us, though not so markedly as in more recent years. Had the French exhibit in Philadelphia been more important, more nearly representative of French achievements in the industrial arts, we might have felt less the English influence, though racial inclinations may have drawn us towards the latter. The German exhibit was also a disappointment, and nowhere was this more promptly recognized than by the representatives of the German government, whose criticism of the neglect of German manufacturers to provide an adequate representation of the arts of that country was most severe. Russia was better represented. But of neither France nor Germany was the exhibit in due proportion to those of some of the smaller powers, such as Sweden and Italy. Notwithstanding the fact that the exhibits might have been much more extensive, more truly inclusive of the broad field of industrial art, still, so keenly did our people realize their own comparative deficiency in esthetics that they promptly seized the existing opportunities, and then began the advance which has since been so rapid. Fortunately Japanese and Oriental art in general was well enough represented to impress upon us as sharply as we were prepared to receive them their ideas of pure and consistent use of form and color in decoration.

The history of the art museums and art schools throughout the country affords important evidence of the change in art culture that has taken place since about 1870. As was stated above, this movement did not actually begin in 1876, though it received its most powerful impulse from the Exhibition. The Metropolitan Museum of Art in New York city was incorporated in 1870, about the time when the first steps were taken in Boston towards the Museum of Fine Arts there. The United States National Museum in Washington—though perhaps hardly to be mentioned in this connection, from the fact that it is a scientific museum, with only an incidental artistic side—may be referred to because its present growth is so directly the result of the Exhibition of 1876, at the close of which it received the entire official exhibits of thirty-four foreign States and colonies presented by their governments to the American peo-

ple. These accessions of 1876 required more than three times the space for display demanded by the previous collections of the Museum. In Philadelphia the Pennsylvania Museum and School of Industrial Art was incorporated in 1876, to take charge of collections of objects of industrial art secured at the close of the Centennial. In Cincinnati an art school was started in 1869, and in 1881 the Cincinnati Museum Association was incorporated as the direct result of the efforts of women of Cincinnati, who had been inspired by their experience in Philadelphia. A like activity is to be found in Chicago, St. Louis, Washington, Detroit, and in other places.

The astonishing growth of the collections in these museums since 1876 is one of the most encouraging indications of public interest in art culture. The museums in New York. Boston, Cincinnati, Chicago, St. Louis, Washington, Philadelphia, and Detroit constitute centers from which already strong esthetic influences flow. Others are to be added in Cleveland and Pittsburgh. Chicago will have this year opportunities for the extension of her already admirable museum, such as rarely occur in the history of like institutions. But patrons of museums elsewhere will find rare chances for strengthening the art influence of institutions in which they are interested.

It is instructive to compare the means of support of art institutions in Europe and this country, especially for the reason that this comparison shows how completely the future development of American art and art industries is dependent upon private enterprise and the public spirit of citizens. Whatever we are to do in art, it will be individual, and not an art fostered by government. Under our political system it seems impracticable that the State shall take any immediate part in art education. Even thus, there will be many ways in which national, State, or corporate government can encourage art without going beyond the sphere appropriate to political action. Whatever architectural or decorative beauty the exhibition buildings in Chicago possess we owe to the individual skill of our architects and the taste of the men whose personal attention has controlled there. In Europe the influence and resources of national government would have been thrown into the task of accomplishing this result. All the more credit to American enterprise.

As a general principle it may be stated that the culture of a people is measured far more accurately by the degree of development of its industrial arts than by the higher esthetic expressions

of its fine arts ; since these industries exist for the purpose of satisfying wants more or less widespread and distribute their products through channels comparatively inaccessible to the great works of sculpture and painting. Without the commercial prosperity assured by this demand manufacturers do not long continue to produce objects of art. This is opposed to the experience of painters and sculptors, whose work is frequently so far in advance of their time that it is encouraged neither by financial support nor even by an intelligent comprehension. The supremacy of France in art and most matters of taste has been maintained through several centuries by her artisans rather than by her artists. It is the comparatively high development of art industries that has in a measure made possible the great painters. The great art finds an essential foundation in the less. Nor can we expect a healthy support of American artists by American buyers of paintings until from persistent contact with multitudinous products of art industry our people shall have acquired not only spasmodically sound ideas of beauty applied in simple forms, but even more than this,—the habitual association with things possessing esthetic interest, to the point that their absence will be to a degree painful.

To secure material advance in industrial art in this country we need more extensive provision for technical training in schools, that we may prepare here, as is done in Europe, skilled workmen and superintendents who will be fitted to direct intelligently the operations of common laborers. I mean schools for immediate instruction in the processes employed in the applied arts ; schools for the teaching not only of drawing, painting, and modeling as fine arts, but of decorative art in all its applications, and for technical and scientific training in the purely mechanical processes of the art. Further, a different conception of the value and dignity of the applied arts must be cultivated among our young men and women who are seeking occupation in art. A large number of purely art schools are now firmly established and are prospering in many cities throughout the land. They are crowded with students, especially women, ambitious to become artists, pursuing art with a restless hope of success and fame, to be won somehow or other, rather than with that persistent search for truth, and the means of expressing it when found, which is characteristic of a real artist. It is a natural impossibility that all, or even a respectable minority of these students can become artists whose works shall have any permanent worth as fine art. Gradually year by year some drop

out of the race, to teach, or to abandon art altogether. How much more satisfactory to themselves, and how much more useful to the community, if their activity could be continued in the applied arts, for the training in drawing and painting already received would especially help them in the study of industrial art in some appropriate school. So far as remuneration for decorative work is concerned, it is on the average far better than in the painting of third and fourth rate pictures, or the modeling of statues no one cares to see a second time. If we are to carry our industrial arts much in advance of their present state, steps must be taken in this direction of raising the study of applied art to a higher plane. In no other way can we secure a corps of trained designers, superintendents, master-workmen, and skilled artisans.

Of one thing we are assured in Chicago, and that is a unique architectural display, one new in the history of international exhibitions. The conception was a departure from anything yet done on a like occasion. The grouping of the buildings for harmony of effect, the design and elaborate decoration of the buildings in themselves, and the landscape gardening,—all this is an artistic creation of a high order. Having accomplished this, there remains the serious task of installation of exhibits in such manner that imposing exteriors may be balanced by equally fine interiors; that groups may be so arranged as to teach most impressively the lessons we are to learn of the arts abroad: for, after all, *it is this educational feature that is the backbone of the exhibition, according to which it will be judged a success or a failure.* It would be unfortunate, indeed, considering the skill, energy, and money expended on this beautiful assemblage of buildings, if they should prove ill-adapted for the purposes for which they were erected, either by reason especially of their height and the vast spaces they occupy, or by an inartistic or unintelligible installation of the objects constituting the very essence and life of the exhibition. In the construction of exhibition buildings the primary and superior thought should be to provide as economically as possible for the safe and most practicable and instructive arrangement of industrial and other objects, and not to dwarf or render them of secondary importance by a grand display of buildings and architectural effects. Utilitarian structures are nearly always pleasing, the more so when they express distinctly the real objects to which they are to be applied. But those who have had experience in similar work should be lenient critics, for they know the problems to be solved.

THE GREAT WALL OF CHINA.

By John A. Church, E. M.

THE Great Wall of China is not all that its local name implies. The Chinese call it the Wall of 10,000 *li*, which would make it more than 3000 miles long, but its actual length is probably only half that. For much of its length it is merely a rude rampart of stones, or sometimes of earth, but there is another part that is deservedly called "great," being a continuous wall of brick on a stone foundation, twenty-five or thirty feet high, and extending for hundreds of miles along the mountain crests of a most difficult country. Even in its shortened dimensions it is the largest ancient work of which we have knowledge. When its construction is examined, we are obliged to diminish our admiration about as much as we did its length, for the wall is not one of those marvellous buildings of massive stone which still command our respect and compel us to admit the engineering ability of the ancients. It is as an example of a great work of high antiquity still existing in remarkably good preservation that the wall is to be chiefly valued, but an examination of its details also shows that it was really a stupendous undertaking.

The best part of the wall is its eastern end, from the point where it runs into the sea at Shan-hai-kwan, on the Gulf of Pechili, westward to beyond the longitude of Peking. The whole of this country is mountainous and very rugged, and this situation was chosen with design, for the purpose of the builders seems to have been to select the line which offered the greatest natural obstacles to an invading force and increase its difficulties by this artificial barrier. Such a situation added materially to the burdens of construction, but these were not shirked in the slightest degree. The wall is carried straight over the steepest and highest peaks, which were granitic wherever I saw them, and perhaps form the central portion of an extensive mountain chain. Many of the situations it occupies would not be defended by a modern engineer, for they are precipices too steep to be practicable for any but the smallest straggling parties. These situations are so difficult as to account for the story current among the Chinese that the bricks for the wall were tied on the backs of goats which were driven up the mountains.

Gates were placed at all the streams, and in the larger or more frequented passes strong interior works consisting of square forts, towers, and curtains were placed. It is rather remarkable that these accessory works are often in complete ruin, while the wall adjacent is in good preservation. Kou-pei-kou, the "Old North Gate" near Peking, is one of the best fortified points and is still a military stronghold and headquarters of a large district. Outside of the main work, often at the distance of a day's journey, there are isolated towers, which were designed not only for watchers, but for signalling by means of large fires, the blackened remains of which still exist.

I passed the wall at three different points, the extremes being about 100 miles apart, and found the mode of construction to be the same everywhere. Two continuous level faces were cut in the solid rock about twenty-five feet apart, and upon these foundations squared granite blocks were laid to the height of two-and-a-half to four feet. It is to this careful preparation of the foundation that the permanency of the wall is due, for the upper portion is made of bricks backed with earth. Even with this good foundation it is remarkable that a structure so liable to attack by frost should stand so long in a country where the cold is extreme. No doubt the dryness of the climate aided materially in its preservation.

Upon the granite bases two walls of brick were raised to the height of from twenty to thirty feet. Only in ascending nearly vertical precipices are these dimensions reduced. The bricks used are 22½ inches long and half as many inches wide and high, the end being square. Such bricks are still made and used in the repair of city-walls. During my visits to Jeho, where the Emperor's hunting palace is situated, I saw in progress extensive repairs to the river wall and to the palace walls, witnessing the whole method of construction. Each of the two parallel brick walls is one brick thick, or 22½ inches. The bricks are all "headers," and laid in lime mortar, which is by no means well made. The mortar remaining in the old walls may be crumbled between the fingers, offering a striking contrast to the excellence of ancient Roman work, where the strong mortar gives a sufficient reason for the endurance of arches that are older than the Christian era.

As the walls rose the interior space was filled with earth well rammed down. There was no selection of materials for this filling, some places showing a mass of broken stone, sherds perhaps from

the stone-cutting, with so little earth that the mass runs down if the wall is breached. All of it, however, was well rammed, and the favorite mode of doing this was by heavy, rounded, flat stones, the edges of which are pierced by a number of holes, affording an attachment for a dozen ropes. These are grasped by a gang of men, who jerk the stone up two or three feet and let it fall to the measure of a rude song. The work is rhythmical, but I noticed that the pauses lasted through many more beats than the moments of activity. Besides the stones ordinary pavers' rams are used, the latter especially in the interior parts of the work, while the more effective stones are employed to finish off the top.

The top of the wall, twelve to fifteen feet wide, is paved with bricks, and a line of battlements breast high built on the outside or northern face. In laying out the line of the wall projecting faces were built every few hundred yards so that the wall forms a series of salients and curtains through its whole length, and the salients were carried to a greater height, making towers. Viewed from the Mongolian side, it presents the aspect of an interminable series of towers, about forty feet high, connected by strong curtains.

The facts given make it possible to calculate approximately the quantities required for the construction. Various dimensions for the wall at different points are given by travelers, from 30 feet high and 18 feet wide on top to 20-25 feet high and 10-12 feet wide on top. Where I saw it the height was about 25 feet and the width on top 12 feet, besides the thickness of the parapet, 22½ inches. The height varies extremely because the inequalities of the ground are taken up in this dimension. For the purposes of the calculations which follow I should say that a good average would be 25 feet in height, 22 feet width at bottom, and 14 feet width at top. For one mile of length in these dimensions the quantities of work and material would be:

Surfacing foundation 5280x2x2, mostly and probably entirely rock cutting	21,120 square feet.
Granite courses 2 feet wide, 2½ feet high, dressed stone, 5280x5x2	52,800 cubic feet.
Brick walls 22½ feet high, 22½ inches thick, each about 42.2 cubic feet per running foot, 5280x42.2x2	445,632 cubic feet.
Brick parapet, 5280x2x1.79	18,902 cubic feet.
Brick pavement, 5280x5½	29,040 cubic feet.
Total brick work	493,574 cubic feet.
Earth filling, 301 cubic feet per foot, 5280x11.15	58,872 cubic yards.

I do not know of any traveler who has defined the length of this best portion of the wall. About 250 miles west of the eastern end the wall branches, one part going to the northwest and the other to the southwest, and from the latter branch a third separates and goes almost due south. The positions of these branches probably represent the advancing frontier of China in its contest, lasting for centuries, with the northern and western tribes. In the second branch is situated the important gate in the Nan-Kou pass, which is one of the show-places of the wall and the one most visited by strangers. West and south of this point the wall loses its continuity and is represented by detached works at the passes or is formed of the stone and earth rampart spoken of.

In calculating the quantities of material used in the best part of the work we may assume a length of 250 miles, which is probably a *minimum*, and we should have—

Surfacing foundation	5,280,000 square feet.
Dimension granite	13,200,000 cubic feet.
Granite facing at 25 square feet per running foot of wall,	33,000,000 square feet.
Brickwork	123,393,500 cubic feet.
Number of bricks	73,683,000.
Earth filling	14,718,000 cubic yards.
Comparing this with modern brick work, the quantity of North river bricks required would be	3,131,527,500.

These estimates are *minima*, the towers not being included nor the elaborate granite work in many important gates.

The only reduction this estimate would be subject to is possibly in the item of pavement, which in some places, and probably for a large part of the wall, is made of small cobble-stones. On the other hand, the battlements have a triangular coping, which I have not accounted for. These quantities do not include any interior works or single towers. They constitute a large work, but nothing to excite wonder in comparison with modern undertakings. Considered in relation to the means of the wall builders and the difficulties they had to meet, they are really formidable. The Chinese say that one-third of the whole population was forced to work on the wall, but that means of course the population adjacent to the wall. Another story—that it was completed in ten years—is incredible, though it has been carelessly accepted by some historians.

When we regard the character of the work, we see as usual two classes of laborers employed,—the skilled and unskilled. The carrying of materials was probably done entirely by men and women,

and an immense amount of this crude labor was needed for making brick, mixing mortar, and tamping. Achievements like this are not wonderful in China, which was a thickly populated country twenty centuries ago. History says that an army of 300,000 or 400,000 men was sent to drive the northern barbarians back and was retained in the country for the purpose of building the wall. No doubt the available local population was also pressed into the work.

Such dispositions explain the provision of crude labor, but since my experience in China I have always wondered where the skilled workmen came from. Aside from four square feet of rock surfacing for the foundation, there would be from thirty to forty square feet of squaring and facing on granite for each foot of the wall. I have had this work done in China. My engine foundations were of granite got out of river boulders, as the wall blocks undoubtedly were, and after an experience of the tedious slowness of Chinese workmen I looked at the wall with great respect. It must have been a tremendous task to collect men enough to do this work. China is distinctively a country of mud and brick habitations. Stonework in dressed material is by no means common, and I should say that at the present day there are not stone-cutters enough in China to make a visible impression upon 250 miles of new wall in ten years.

In brick-making my wonder took another direction. The large bricks used in the wall, containing nearly one and two-third cubic feet each, require not only the best skill, but the best clay. The labor could be obtained, but my experience in the very country of the Great Wall taught me that supplies of proper clay were few and far between. Several months passed before we could find any available clay nearer than thirty miles from the mine, and the supply obtained there was too poor for making large brick. The makers of the wall must have been hard pushed to find what they wanted, and it is probable that the whole great bulk of the brickwork was transported overland, principally by human carriers, for distances of at least thirty miles, besides its distribution along the wall.

The quantities of material used in the wall are not remarkable when compared with modern railroad building, but the expenditure of *labor* probably surpassed anything we know. We have almost eliminated labor from transportation, brickmaking, and lifting to the top of the growing wall. With the Chinese every one of these tasks called for an army of men. The provision of say 20,000,000

yards of earth filling was probably the least part of the task. Nowadays no engineer would hesitate to contract for 500 miles of railway embankment in China, and he would lay it up with the basket and hoe just as the wall-builders did. Lime-burning and -mixing, laying up the wall, and tamping the filling were by comparison the minor divisions of the work, though they too would call for an immense number of men.

The provisioning of all these non-producers was a task for a general. The quantity of food consumed by a vegetarian is immense, and the neighborhood of the wall is not a fertile region. With only a thousand men to provide for, I had to send a hundred miles for grain, and I doubt extremely if half a million men, in addition to the ordinary population, could be maintained to-day along the line of the wall on supplies obtained within 100 miles on both sides.

Such considerations have a historical value, for the Chinese Wall is an existing work of known dates, which we can measure and compare with the known capacities of the Chinese in the present day. We thus gain a measure of their capacity 2000 years ago. That was one of the remarkable eras of their history. Occupying probably less than one-sixth of the present area of China proper, they were pressing upon the outlying tribes in all directions. The records tell us of almost continual war for centuries, of great expeditions, and of armies numbering hundreds of thousands of men. The Great Wall testifies that these great armies were possible then, that there was population enough to supply them, skill to maintain them in the field, and a system of transport extensive enough for their needs. In this way the wall gives reality to historical records and compels our respect for their integrity.

It is the fashion to speak of the Chinese Wall as being 2000 years old and as having been built in ten years, by the great Ts'in "Emperor the First." The fact is some individual walls were built at least a century before his time, or 300 B. C. He conceived the idea of uniting these fragments into one great work and extending that until it wrapped the whole of his empire in its defense. The results must have been valuable, for other monarchs repaired, rebuilt, and extended the Wall. Known dates of such repairs are the sixth and fourteenth centuries, and no doubt there has been occasional work of repair that is unrecorded in our translations. The date of the wall that I have described cannot be determined positively, but as the work of the Mings, 1352 A. D., was done on the eastern portion of the wall, it is probable that the best part of

the work was at least put in repair at that date. Knowing the recklessness with which the Chinese abandon even important works to decay, I felt sure, on inspecting the wall, that it had not stood more than 500 or 600 years, and while this judgment was mere guesswork, the fact that the very parts I saw were overhauled 600 years ago probably accounts for their good condition now.

The repeated repairs made at intervals of a few centuries may relieve us from the necessity of accounting for the provision at one time of the great mass of materials required. It is more probable that the wall was never continuously complete until the Mings finished it. They worked over the old material and added to it, but there is little probability that the quantities I have calculated were obtained at one effort. They are the accumulations of a series of successive builders.

The position of the wall on the line of highest elevation accounts in part for its preservation, for, though it crosses a greater number of ravines, they are less watery and less sandy than lower down. Where it has crossed a valley of considerable width, it has often suffered much destruction. There is dilapidation, of course, at many places, but it is confined usually to the falling down of bits from the rampart, shoving of the foundation, and bulging of the outer or more vertical wall in places. The last two injuries are caused no doubt by frost, and it is remarkable that a wall puddled with earth, as this is, should have stood for 2000 or even for 500 years in a climate like that of Massachusetts, though dryer, without greater injury. The bricks are not pitted, nor the mortar washed from the joints, and the aspect of the wall is stately and imposing, though its interminable length in any point of view lessens the effect of its height. Blue bricks are not very strong, and as the mortar seems to have been no better than modern Chinese mortar is, I ascribe the really remarkable preservation of the structure to the careful levelling of the foundation and to the broad face of the bricks.

STATE-OWNED RAILWAYS IN AUSTRALIA.

By Richard Speight,

Ex-Chairman Victorian Railway Commissioners.

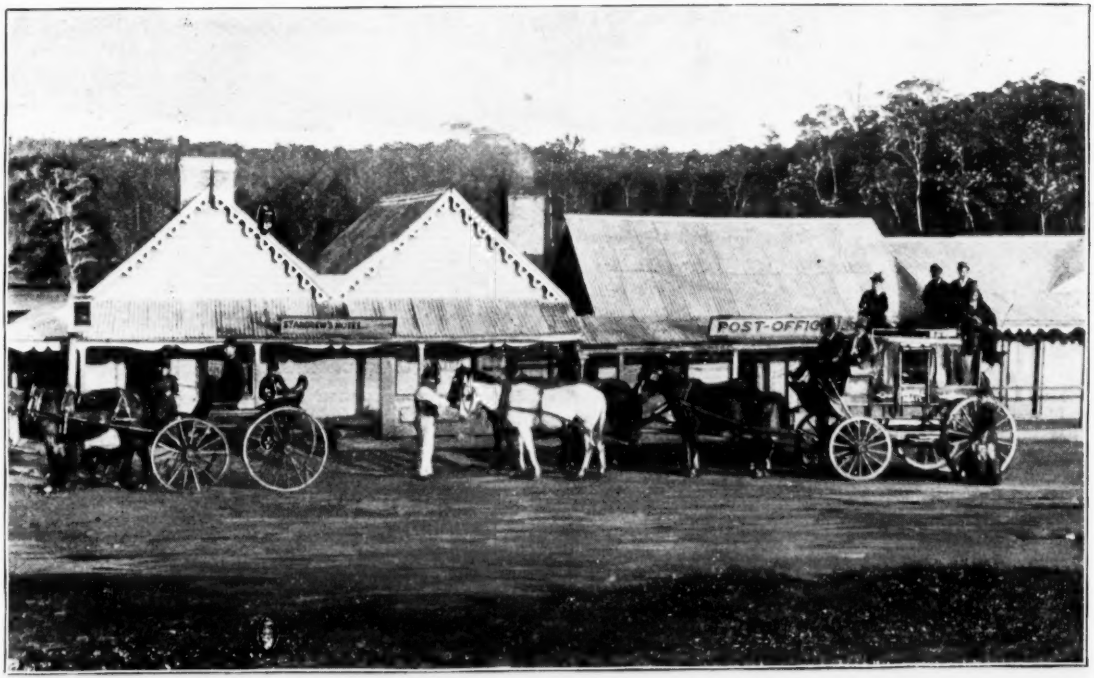
THE question whether the railways of any country should be owned privately or by the State is debatable. In old-established communities, already accommodated by private enterprise, I should say it is advisable to continue the existing system of ownership and management, as affording the best protection for the public interest and freedom from difficulties associated with a condition of things under which a Government may become a large employer of labor; but in new communities and countries it is different. There is a necessity for opening up and peopling the lands of such colonies more rapidly than private enterprise could undertake, and to construct railways becomes of the first importance. This is the case in Victoria; but it applies, in perhaps a less degree, to some of the neighboring colonies, where longer reaches of territory exist still in the hands of their Governments, which might induce private capital upon a land-grant basis to enter into competition with Government expenditure. That State-owned railways are possible in Victoria, and can be conducted with advantage, is proved by the experience of the Commissioners during the earlier and larger portion of the eight years they directed the administration of the railways of this colony. That the past results can be perpetuated is undoubted, provided always that fair and business criticism only has to be contended with. If, however, difficulties are created by political or other exigencies which leave the arena of fair and business-like comment, then the principles and usefulness of the Commissioners' management inaugurated in Victoria in 1884 are in jeopardy, and it is only a question of time when we will get back to the position of things which existed under political patronage and political management, and which are still fresh in the minds of statesmen of that day, but are forgotten or not known by those, not then, but now engaged in the ever-recurring strife between the "ins" and the "outs."

One thing quite certain is that the political and private systems

NOTE.—The force of the author's remarks will be better realized when it is understood that evils and scandals of marked enormity were found inseparable from political control in railway administration in the Australian colonies,—evils which Mr. Speight truly says many present-day critics appear entirely to forget.—THE EDITOR.

cannot very well overlap. The choice of one must be made. A reversion to the political system as indicated by the legislation of 1891 must be followed by a repetition of the difficulties which were formerly experienced, intensified by the fact that business is now twice as great as it was eight years ago. The figures relating respectively to the two periods of administration prior to and after 1883 will enable any one to judge how far this is permanently desirable. They afford food for reflection as to whether the legislation of the last two years in Victoria was intended or not to end in the State relieving itself by the lease of its railways or otherwise, and it is not improbable that this goal will by means of that legislation be ultimately reached. It is for the people of Victoria to consider seriously what this possibility means to them, but it will hardly be disputed that the legislation of 1883 was honestly intended to get rid of difficulties then too great to be allowed to continue, and that the Commissioners' interpretation of the duties such legislation impressed upon them was a recognition and practice of economy in management, consis-

RICHARD SPEIGHT.



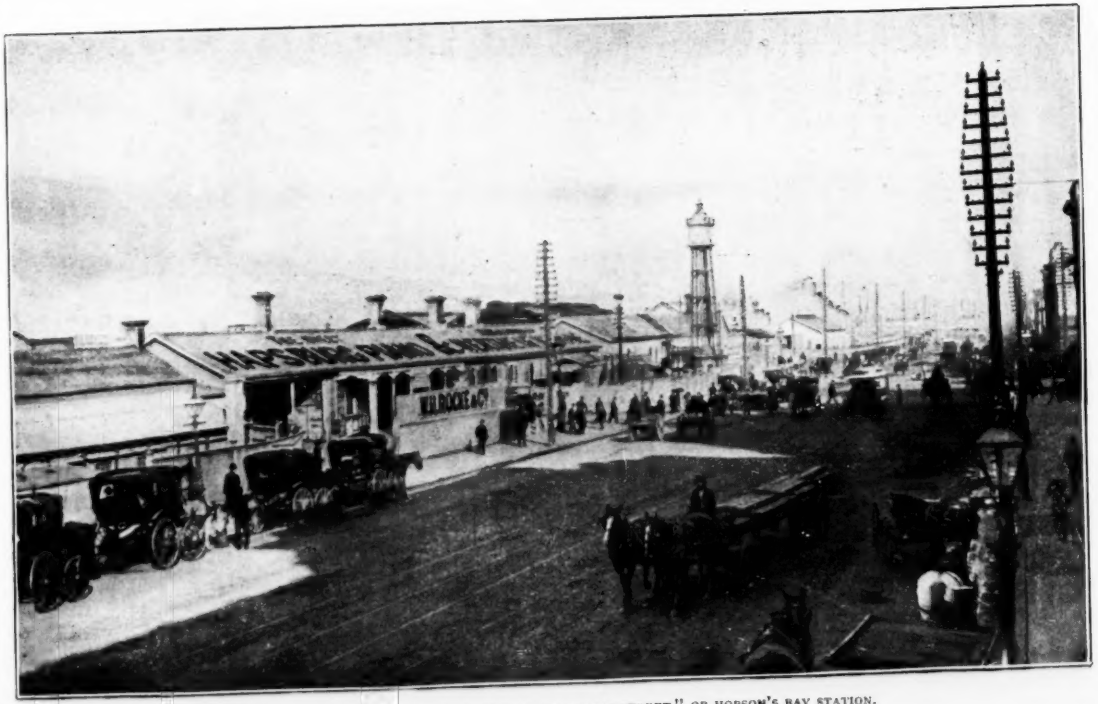
THE ROYAL MAIL-COACH AT A BUSH TOWNSHIP.

[A familiar sight to-day all over Australia.]

tent with reasonable facilities to the public to use the railways advantageously.

At the time the Parliament of Victoria decided to transfer the administration of its railways from a political head to a business management under a board composed of three Commissioners, there were many reasons given for taking this step. The debates on the question disclosed that members were of opinion that a business like the railways was too large to be properly controlled by a political head who was liable to be in office to-day and out to-morrow, and could not therefore have a continuous grip of railway administration so necessary in the proper management of such a department. This was in 1883, and at the time I was the assistant general manager of the Midland Railway of England. I entered that service in 1850 and passed through nearly all grades until I reached the second position in the general administration of one of the six leading railways of the old country. I may say without egotism that I was what barristers would call the leading junior of railway managers. My future career was assured if I had remained among the English railways, and I was therefore in a position to consider quietly and calmly, uninfluenced by any necessity or desire for improvement in pecuniary conditions, any overtures made to me to be the first to try the experiment decided upon by the Victorian Parliament; to relieve political men of the difficulties associated with the system superseded by the legislation of 1883, and at the same time retain for the benefit of the people the present and future value accruing from the carrying resources of the country.

When first approached in the matter by the then Agent-General of Victoria, Mr. Murray Smith, I was shown by that gentleman a copy of the bill which was passing through the usual stages of legislation, and which ultimately became an act without any alteration of importance. He at the same time entered fully into the many reasons which had influenced that legislation. He explained that, as the bill provided, whoever undertook the important trust would be practically in a position to manage the department in a business way. At the outset I pointed out to the Agent-General that my railway position at home did not warrant my becoming an applicant for the appointment of Chairman of the Commission; but I, however, appreciated the honor of having been approached on the subject, and if his Government authorized him to offer me the appointment I would favorably consider it, as I felt there



THE FIRST RAILWAY STATION IN VICTORIA—"FLINDERS-STREET" OR HOBSON'S BAY STATION.
[Photographed in 1892. The station is still in use.]

would be great interest associated with an experiment the practicability of which in relation to railways elsewhere had been frequently discussed. Ultimately, and without the slightest seeking on my part, that offer was made, and I unconditionally accepted it on the faith that what was intended was expressed in the bill which formed the basis of the discussion that led up to the offer.

The area of the Colony of Victoria is about that of Great Britain, and at the time I reached the Colony, in February, 1884, the mileage of railways opened was 1562 miles. The gross revenue for the year ending December, 1883,* was £1,898,311 and the net revenue £624,389. On my arrival I found my two colleagues, Messrs. Agg and Ford, installed in office, both business men of great and general experience, and selected, as I was informed, so that the Commission might not be hampered by any predilections in favor of previous railway administration. We commenced our duties and continued them throughout on the lines of our act with results so satisfactory that approbation followed our steps. Imitation is said to be the sincerest flattery, and it was pleasing to see that all the neighboring colonies, after waiting nearly four years, followed the example of Victoria and placed their respective railways under the management of Boards of Commission. This, I think, entitles the Victorian Railway Commissioners to conclude that their efforts to solve the problem had been recognized.

In writing this paper I have no intention of commenting upon the official administration of the railways prior to our advent. It may or may not be that had it possessed our powers it could have done better than it did. I only deal with facts and leave my readers to draw their own conclusions. The following table shows the revenue derived from the Victorian railways and the expenditure associated therewith, for the three years ending December, 1883, the Commissioners taking the reins in February, 1884:

	Revenue.	Increase on 1880.	Expenditure.	Increase on 1880.
In 1881 ..	£1,665,209	£162,292	£ 913,572	£109,497
In 1882 ..	1,781,808	278,161	1,098,599	294,524
In 1883 ..	1,898,311	395,394	1,273,921	469,846
		835,847		873,867

A glance at the figures shows that the income was satisfactorily growing, but a reference to the outgoing shows that the expenditure kept greater pace, and that it exceeded the original income by

*The railway reports in those days ended in December, and subsequently, as provided in the Commissioners' Act, in June of each year, so as to correspond with the general financial year.—R. S.

BRITISH AND AMERICAN SHIPPING, PORT MELBOURNE PIER, VICTORIA.

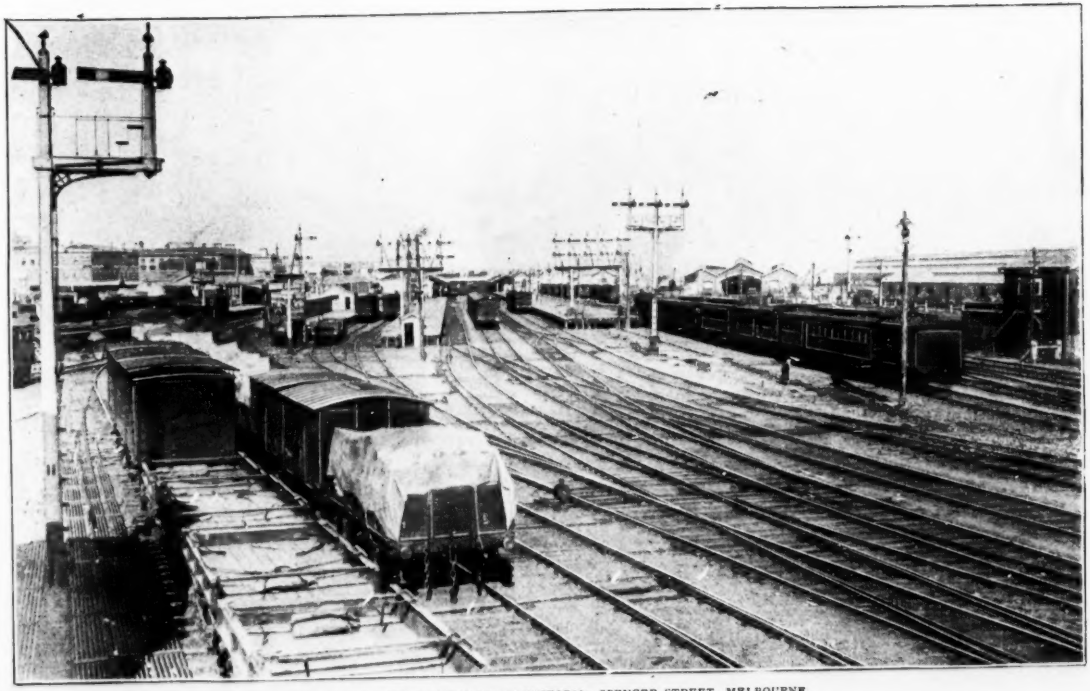
£38,020, or in other words, that working expenses absorbed all the growth of traffic and the sum named besides. We turned our attention to controlling the department as the conditions of our appointment required us to do. The following table, made out on the same basis as the preceding one, gives the result for the first three years of our administration :

June.	Revenue.	Increase on 1883.	Expenditure.	Increase on 1883.
1884-85 ..	£2,181,932	£283,621	£1,277,425 ..	£ 3,504
1885-86 ..	2,329,126	430,815	1,310,538 ..	36,617
1886-87 ..	2,453,078	554,767	1,427,116 ..	153,195

As a contrast to the preceding three years, absorbing all and more than all of the growth of the revenue, our first three years of working showed an additional expenditure of £193,306 to earn an additional revenue of £1,269,203, or a gain to the State of over a million sterling of net revenue. These results were appreciated at the time, and other colonies saw the force of them. Our plan of administration has from the commencement been the same, and has not in any way changed, so that subsequent results do not arise from change of practice. They are the consequences of outside circumstances. The figures should, however, afford even a novice an idea of the advantage to the State of the later, as compared with the earlier period of working. In addition, the public were benefited by the reductions of charges, amounting in the aggregate, for the three years ending 1886-87, to £250,000.

For some years prior to our appointment many discussions had occurred in Parliament, and many schemes broached for increasing the railway accommodation in Victoria, and these culminated in 1884, Parliament authorizing the construction of about 1200 miles of railway. This construction was estimated to cost about £5,000,000, but the estimate was made on imperfect data, as in many instances permanent surveys had not been made. They ultimately cost about £7,500,000, but Parliament was acquainted with and sanctioned the additional cost. The mode of letting the work assured the State getting value for the money, and the property is a solid asset for every penny spent upon it.

Leaving the difficulties of present depression,—which are in no way connected with railways, and which unfortunately for most in this world (old as well as new) are recurrent factors,—it is interesting to contrast our railway expenditure and its results as an investment, in order to see what cause there is for alarm. I see none. Some people, if they consider it worth while, will blame me for



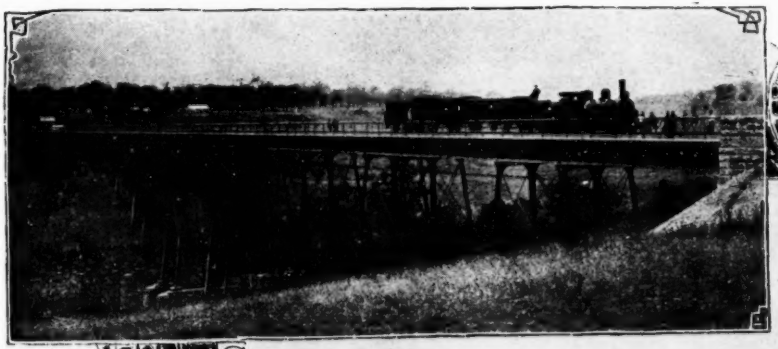
PRINCIPAL RAILWAY TERMINUS IN VICTORIA—SPENCER STREET, MELBOURNE.

[The Trunk-Lines to Sydney and Adelaide begin at the platforms here shown.]

being optimistic, but facts are stubborn things. Considerable comment has arisen latterly about what is termed the railway deficit, but it is not necessary for the purposes of this paper to seek the causes for that cry. Unfortunately, however, as it has been put before the public, it has created considerable misapprehension even in the community in which we live. How much greater, therefore, must its effect have been among those living 14,000 miles away from us and upon whom we depend for a response to our borrowing requirements. For the last eight years it has been the practice of the Railway Commissioners of Victoria to charge their annual accounts with interest upon expenditure, whether incurred upon lines opened or to be opened. This is a very healthy practice, having regard to the permanent character of the investment, but somewhat burdensome for the time being, and still more so if the fact is not overlooked that railway-mileage in Victoria has during the past few years been nearly doubled. With all these burdens, the net results since 1884 give the following dividends on the capital cost of the railways (which included between three and four millions taken from general revenue) and on the debenture capital, which represents the loan money invested in the railways opened for traffic:

	Profit on Capital Cost of Railways.	Interest on Loan Money invested.
In the year 1885 ...	4.03 per cent.	4.54 per cent.
In the year 1886 ...	4.31 per cent.	4 77 per cent.
In the year 1887 ...	4.15 per cent.	4.64 per cent.
In the year 1888 ...	3.79 per cent.	4.22 per cent.
In the year 1889 ...	4.01 per cent.	4.20 per cent.
In the year 1890 ...	3.14 per cent.	3.44 per cent.
In the year 1891 ...	2 78 per cent.	3.0 per cent.
In the year 1892 ...	2.64 per cent.	2.87 per cent.

These figures give no cause of alarm, and should be a matter for congratulation, more especially as the Victorian Railway expenditure includes at least six millions sterling on lines not on the average a year and a half old, and which represents a present annual charge for interest of £240,000, affecting the above-named dividends to the extent of nearly 1 per cent. The net results obtained from American railways is 1¾ per cent. on over £900,000,000 sterling, and from English railways 4 per cent. on the entire capital invested. In the two latter cases railway construction has practically been stationary for some years, while that so largely carried out in Victoria is to districts which could not possibly develop until means of transit were in evidence, and such districts being purely agricultural will necessarily take some years to show



RAILWAY BRIDGE CONNECTING MELBOURNE WITH SOUTH MELBOURNE.

THE WERRIBEE AQUEDUCT, BETWEEN MELBOURNE AND ADELAIDE.

the effect of the cultivation now made possible. The expenditure has been astonishingly responsive, as I am sure it will appear to be to those who lend us money, indicating as it does, under all the conditions of a State undertaking to provide the carrying facilities for its community, that the money has been wisely spent, and that under the same circumstances more could be got on as easy terms as any other borrower having the same security. It is a mistake to talk in general terms about deficits, as has been the policy during the past two years. Whatever was the cause of that stand being taken up, it is of recent creation, but its honesty is at least questionable when the following figures are compared :

Balance, after paying Working Expenses and Interest.

	Deficit.	Surplus.
In the year 1872	£263,912	—
In the year 1873	239,303	—
In the year 1874	142,023	—
In the year 1875	238,060	—
In the year 1876	180,990	—
In the year 1877	149,882	—
In the year 1878	141,242	—
In the year 1879	166,224	—
In the year 1880	118,187	—
In the year 1881	84,181	—
In the year 1882	200,161	—
In the year 1883	235,611	—
In the year 1884	39,579	—
In the year 1885	—	£61,483
In the year 1886	—	40,457
In the year 1887	53,681	—
In the year 1888	—	34,060
In the year 1889	221,482	—
In the year 1890	332,116	—
In the year 1891	430,046	—

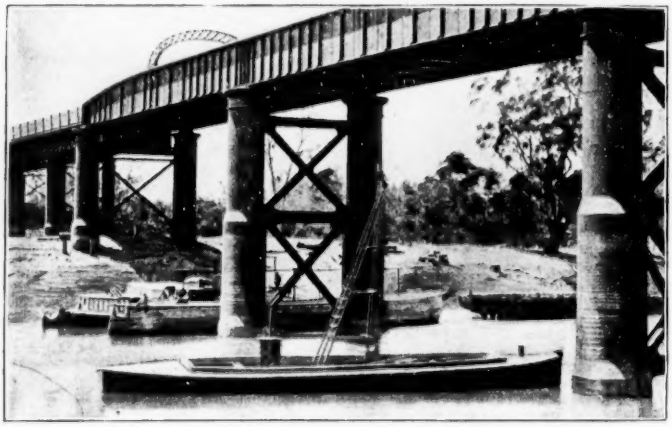
It will be seen that until 1883 the debit was always on the wrong side; that a change followed in the next four years, being those of our first years of administration; and that the temporary reversion to a condition of not realizing net revenue equal to the interest on loans was caused by the enormous construction which was going on through those years, and which could not possibly, under any circumstances, be immediately remunerative. The Victorian Railways are a first-class security for the money borrowed upon them, and the asset is practically equivalent, looking a few years ahead, to the total foreign public indebtedness of Victoria. The country would not have been developed so rapidly, equally, or fairly if railway construction had been left to private enterprise ; and if the Administration can be afforded the freedom of action intended by the act of 1883, the national interest will be best consulted by the retention of State control over the present railways

FLINDERS-STREET VIADUCT, MELBOURNE, LOOKING WEST.

[Completed 1892. Length, 2300 feet Cost, £74,000.]

and future railway extension. No mixed system of private and State railways is feasible in Victoria. The areas still requiring to be accommodated are districts which do not require much length of railway construction, so that there is no probability of private enterprise undertaking such works, as they would in themselves be too small to be remuneratively worked.

A glance at the map of Victoria will show that, whoever is responsible for the railways of the country, due regard was paid to the development of the country, and to a fair distribution of the accommodation the State was able to provide. Some hold the view that, if it is not in evidence that a railway will pay, it should not be authorized ; but if this doctrine had been adopted from the first,

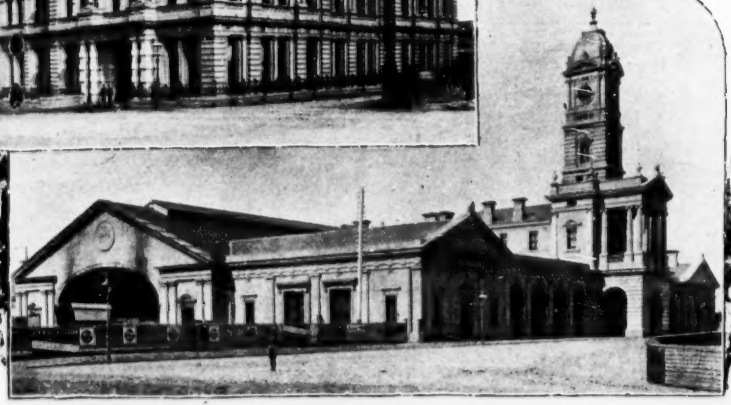


RAILWAY BRIDGE AT ECHUCA, VICTORIA.
[The great Murray River is shown at low level.]

many railways now a direct source of revenue to the State would never have been made, and the development of the country would not have received the impetus the construction of those railways created. Most of the districts now served by the present railways depend upon agriculture for their main products, and would have remained practically in their virgin state if facilities of transit had not been provided. The advantage to the country has therefore been enormous, as compared with a temporary inability to earn a sufficient net revenue to cover the entire interest upon the moneys invested in the railways.

It may be that the present generation cannot undertake to bear

THE NEW OFFICES OF THE VICTORIAN RAILWAY DEPARTMENT.
[Built under Mr. Speight's regime.]



GREAT CENTRAL RAILWAY STATION, BALLARAT, VICTORIA.

the burden of immediate expenditure, which is not intended for present requirements only, but, as it properly should do, contemplates the necessities of the future. The country's development ought not to stand still on that account, and if temporary difficulties are too great, and inconsistent—under present conditions—with the development of this splendid Colony, it is surely within the ability of its statesmen to reconcile and arrange a distribution that will not bear too hard upon the present, and at the same time not give our successors grounds for saying that we had no confidence in the resources of the country. The question of making only railways that will pay (whatever that elastic term may mean) is associated with the consideration that any one who has to deal with the question cannot disregard the condition that, so long as the State decides to be the railway-provider, it must to the extent of its ability fairly distribute its accommodation. That is to say, it cannot satisfy one section of its community with a statement (based on hard swearing and accumulation of what some would call evidence and others would not) that a district, remote from the interests of that section, should have the benefit only of the railway expenditure it is for the time being in a position to incur. The only true principle is for responsible statesmen to determine to what extent and under what conditions liability for future railway construction, fairly distributed, shall be undertaken ; that decided, there need be no fear of the result.

I have dealt with the Victorian railways, because they have been managed during the last eight years by a Commission appointed by a State desirous of being relieved of administrative details, and at the same time retaining State ownership. I contend that the results obtained prove the practicability of State ownership with private administration. The railways have been managed and controlled as they would have been managed and controlled if they had been mine and my colleagues' own property.

The difficulties created by outside and partial criticism are inconsistent with the conduct of a business by business men, and, whether a railway is State or privately owned, it is none the less a business. The great danger against the success of the experiment lies in this direction, particularly when associated with created political movements of the day. Training and experience are required in railway work quite as much as any other work. Take away confidence, the supply will cease ; and ultimately the end must be chaos or some other result equally detrimental to public interest.

PROGRESS IN PNEUMATIC TRANSMISSION.

By William Allen Smith, E. M.

THE principle of all systems of pneumatic transmission, in the usual sense, is the utilization of an air-current through a tube to propel a suitable car or *carrier* containing letters, parcels, or even passengers. Air-tubes for conveying grain, sawdust, etc., *in bulk*, are not now to be considered. The medium of transmission, atmospheric air, is inexhaustible. The practical questions which arise will relate to:

I. The means of setting the air-current in motion.

II. The construction and dimensions of the air conduit.

III. The car or carrier.

IV. The methods of starting and stopping the carrier.

V. The appliances for switching the carrier to any given station on a pneumatic line.

The idea of pneumatic transmission was announced as early as 1753, by Papin. In 1810 and 1812 Medhurst, a Danish engineer, published in London articles on "A New Method for Transporting Parcels and Letters by Air." In 1818, Vallance, an English engineer, proposed to build a large cast-iron tube to transport passengers and merchandise between London and Brighton, using a car on rails, provided with a piston fitting the tube walls, and propelled by exhausting the air at the end towards which the car was to move.

This idea of pneumatic railways has been followed by several experiments on a large scale. In 1861 an experimental pneumatic tube, 30 inches in diameter and a quarter of a mile long, was laid near Battersea in England, with grades and curves purposely introduced. A train of two iron cars, weighing 700 pounds each, carrying mail bags and parcels, was successfully propelled through this tube. The same tube was removed to London, and there used to transport the mails from Euston station to the northwestern district post-office.

Following this experiment, a pneumatic dispatch company constructed in 1864 a tube $4\frac{1}{2}$ feet in diameter, from Euston station to St. Martin's-le-Grand, $2\frac{3}{4}$ miles, with three way-stations. The tube was laid at a small depth below the streets, and was of cast-iron with curves of brick. A car ran on tracks inside the tube, and was

propelled by air from a blast fan, 32 ft. in diameter, at the Holborn station, midway, one-half of the transit being by suction and the other half by pressure. The fan was reversed for the back transit. The cars were 10 feet 4 inches long, and twenty-four trains, weighing 240 tons, were moved by ½ lb. pressure in four hours. In the same year a car on rails was operated through a tube 1700 feet long at the Crystal Palace, London, for the conveyance of passengers. This tube or tunnel was 10 ft. high and 9 ft. wide. A pressure of 2 or 3 ounces sufficed to carry the car over a steep gradient.

In this country, Mr. A. E. Beach exhibited a large tube with car for passengers at the American Institute Fair in 1867, and the Beach Pneumatic Transit Company obtained in 1868 the right to operate pneumatic tubes underground in the city of New York. Early in 1870 this company had constructed and operated a tube under Broadway, 4½ feet in diameter, from Warren street to Murray street, which was described in the daily papers at that time, and in the *Scientific American* of March 5, 1870.

Inventors have likewise been busy with attempts to operate pneumatic railways on a system proposed by Medhurst in 1832,—namely, by applying the power to a piston moving through an independent air-tube and connected with a car moving on a track outside of the air-tube. This system presents the obvious difficulty of keeping closed the slot in the air-tube, through which passes the connection between piston and car. Several closing-devices have been proposed, one of which is shown on a pneumatic railway recently exhibited in Philadelphia; the slot is closed by a series of square slide-pieces, moved out and in by a curved groove in the connecting piece, which engages with pins, provided with friction rollers, on the top of each slide-piece, thus automatically opening and closing the slot as the car advances.

Up to this time no pneumatic railway has come into extended use. There can be no doubt of the convenience of such railways; the question is as to the economy in the application of power.

Complete success has, however, been attained in the transmission of letters and telegrams through smaller tubes. As early as 1852 a trial line was successfully worked by Ador in the park of Monceau near Paris. In 1854 patents were taken out by Cazalat in France and Latimer Clark in England for the same method of pneumatic transmission of letters and small packages, inclosed in metallic carriers. Clark established a line between two departments of the head telegraph-office in London, consisting of two

leaden tubes, a dispatch tube 19 millimeters in diameter and a signal tube of 12 millimeters. The dispatch tube had a cock at each end, by turning which it could be connected either with the outer air or a vacuum reservoir. The signal being given by a whistle through the smaller tube, the dispatching end opened the connection to the outer air, and the receiving end connected with the vacuum reservoir, thus making an air-current which propelled the carrier. This first leaden tube was in continuous use for more than twenty years, and suffered very little from wear. This was the beginning of the extended pneumatic service of the British Post-Office Telegraphs.

In the following years, 1858–1865, the system was improved by C. F. Varley, who used compressed air to force the carriers in one direction, and rarefied air to draw them in the opposite direction. Varley improved the sending and receiving apparatus, and devised valves for changing the direction of the air-current. His appliances made it possible to send and receive messages through a single tube, between a central station provided with air-pumps and an outlying station not so provided.

In both the Clark and Varley systems it was necessary, after the transmission of a carrier, to restore the pressure in the tube to the normal atmospheric pressure before forwarding another carrier, obviously entailing loss of time and power. The double-sluice valve, designed by Mr. J. W. Willmot in 1870, and now in general use in the pneumatic system of London, allows carriers to be dispatched continuously, without stopping the flow of air in the tube. This valve is placed on the end of the tube, the distance between the sluices being a little more than the length of a carrier. A single motion of a handle closes one sluice, opens the other, and at the same time opens (or closes) a valve which admits (or cuts off) connection with the compressed air. The valve acts as both transmitter and receiver,—in the latter case, however, connecting with the vacuum reservoir. Where the same tube is used for both receiving and sending messages (by alternate pressure and vacuum), a single sluice is used, with connections to the compressed and the rarefied air.

Pneumatic tubes for local transmission of telegrams are now used in all the principal cities of Great Britain. At present about 50 miles of such tubes are in operation, requiring an aggregate of 400 horse-power, and transmitting a daily average of over 105,000 messages (or over 30,000,000 annually), more than half of these in

London. The lengths of tubes vary greatly; the average length is about 630 yards; the greatest single length in London is 3992 yards. The tubes are of lead, laid in cast-iron pipes, for protection, and are usually of 2¼ inches inner diameter; some tubes of 1½ and some of 3 inches inner diameter are used. As a general rule, with the same air pressure and diameter of tube, *the speed varies inversely as the length of the tube.* In tubes not over a mile long the usual average speed is 25 to 35 miles an hour. The carriers are of gutta-percha covered with felt, with a buffer at the front end, and an elastic band at the back or open end to hold in the messages. An ordinary carrier weighing 2¾ ounces holds a dozen messages.

The marked success of the British pneumatic service led to the adoption of similar systems in Paris, Vienna, and Berlin. The pneumatic system of Paris was put into operation in 1866, and has grown steadily, so that to-day in Paris tubes are used almost exclusively for transmission of local telegrams and letters demanding quick delivery. A small stamped envelope, the *petit bleu*, costing 50 centimes, or 10 cents, is used for the message, which, dropped into a special post-box, is delivered anywhere in Paris within an hour, often in 25 minutes.

In Vienna the "tube-post" was established in March, 1875. The nine districts of the city are connected with a central station. The "tube-mail" is dropped into special post boxes, collected every half hour, forwarded to the central station, and distributed. Pneumatic envelopes cost 15 kreuzers (about 6 cents); ordinary letters 3 kreuzers. "Tube-letters" are delivered within one hour after mailing. The Vienna system consists of a main circuit of 5.34 miles, with three branch lines; total length 7.2 miles.

In Berlin the Prussian postal authorities began in 1862 discussion of measures of relief for the over-crowded local telegraph system, and a pneumatic line was opened in 1865 between the Central Telegraph station and the Exchange building. The beginning of the present extensive "tube-post" of Berlin dates from 1876, since which time it has been enlarged, until there are now over 28 miles of tube-line in the city, with 38 stations. "Tube-letters" are to-day delivered in Berlin more quickly than telegrams at a cost equivalent to 7½ cents, and "tube post-cards" at 6¼ cents. The tubes in Berlin are of wrought iron, and have an inner diameter of 65 mm., equal to 2.55 inches. The system is operated by eight steam engines, aggregating only 128 horse power.

The British tube-lines are laid on the *radial* system; that is,

the different lines radiate from centers to the various branch stations to be reached. In Paris, Vienna, and originally in Berlin, the various stations were connected by a series of polygons, around which the motion is uniformly in the same direction. A study of the two systems, for connection of a given number of stations under ordinary conditions, leads to the following comparative results:

I. The polygonal system will require about 20 per cent. more tube-length than the radial.

II. The polygonal system allows much greater use of compressed air for forwarding, as the passage around the polygons is always in the same direction. Rarefied air need be used only for the return passage in the links connecting the polygons, or for the return from a single, isolated station. In the radial system, rarefied air is used for half the passages. This shows greater economy in working for the polygonal system.

III. The time consumed in communicating between stations is less in the radial than in the polygonal system. In the latter, time is frequently lost by sending a message almost completely around the polygon, which in the radial system could be sent to the nearest central point much more quickly.

It was this third consideration which led in 1884 to the complete transformation of the pneumatic system of Berlin from the polygonal to the radial system, the saving of time being held to more than counterbalance the increased cost of working due to the greater employment of rarefied air.

While the pneumatic transmission of local telegrams and "quick-delivery" letters and postal cards has thus become a distinct feature of rapid communication in the principal capitals of Europe, it is somewhat surprising that it should have received such slow recognition in the United States. The Postmaster General of the United States, in his annual reports, has repeatedly called attention to the subject, and has finally arranged for the construction of a short line in Philadelphia to connect the central post-office with one of its branch offices. This line is now in process of construction.

The only extensive use made here of pneumatic transmission is by the Western Union Telegraph Company, which has lines in several large cities for local transmission of telegrams. In New York its tube-line runs from the central office at Dey Street to the office at Twenty third Street and Broadway. Small pneumatic systems, requiring but little power, are also coming generally into

use inside of newspaper and other large offices for communication between departments ; also as cash-carriers in large retail stores.

American inventive genius has, however, been at work on this subject, as the files of the United States Patent Office and of technical journals will show. A mere enumeration of the ideas advanced would fill pages, but reference may be made to a few systems.

The Johnson pneumatic system has striking and interesting features. It was described in the *Scientific American* of October 19, 1889, and an experimental line, 1000 feet long, is said to have been operated at Marion, New Jersey. A hollow steel sphere, 29 inches in diameter, having a cover which can be fastened securely, serves as the carrier to hold letters or parcels. This sphere is propelled through a tube of sheet steel, 30 inches in diameter, by air pressure behind and a partial vacuum in front. The sphere runs on a flat rail along the bottom of the tube. At branches and terminals the tube is curved upward and closed at the end ; this makes an air-cushion to stop the sphere, which comes gradually to rest, and then rolls down an opening for withdrawal. At the trial tube mentioned, a No. 5 Root blower, worked by a 25-horse-power engine, made a partial vacuum of $\frac{1}{2}$ pound. This is said to have propelled the sphere, weighing 750 pounds, through the tube, 1000 feet long, in 11 seconds. It was claimed that a speed of 300 miles an hour would be attainable on long stretches, but this is in the realm of fancy.

The use of electricity in foreign pneumatic systems is confined to the signals from one station to another. In this country, however, much attention has been given by inventors to electrical switching-devices. It is obvious that, if a carrier can be switched from a main pneumatic line into any given branch, at the will of the operator at the central station, there will be a great saving of time in comparison with the systems used in foreign cities, which require the stopping of carriers at all stations and the re-forwarding of those destined to go further.

The various electro-pneumatic switches may be divided into two classes : first, those which divert the carrier by making a portion of the air-tube movable under influence of an electrical current ; second, those which divert the carrier by interposing, by electrical action, a movable bar or "fingers" in the path of the carrier. A third class might be made by including the original device of Mr. A. E. Beach, who in 1868 constructed a system in which the carriers were stopped by bars at each station, and those

to go further were released by moving these bars electrically from the central or the branch station. But Mr. Beach in 1869 cut the main tube at branches, and made the cut part movable, thus forming a "tubular switch" for diverting the carriers at will.

Of the second class of electro-pneumatic switches, two will serve as types: the inventions of Mr. E. S. Leacraft and of Mr. Henry Clay. Leacraft's invention consists of movable fingers, working in the main tube and pivoted to it so that the switch normally closes the entrance to the branch. By actuating a magnet, the switch fingers can be thrown across the main tube, and the carrier diverted. Clay's switch consists of a long lever, which plays in the main tube at a junction; the lever, together with a section of the main tube and of the curved branch-tube, being inclosed in an air-tight box. An electrical current energizes a solenoid, the bar of which draws down the back end of the lever so far that the forward end is thrown across the main tube and diverts the carrier. The current is only momentary. The lever is held in place by a pin and pawl until the carrier in its passage into the branch brushes a slightly projecting lever arm, which releases the pawl; the switch springs back to its normal position, and the main line is left open after diversion of the carrier.

On a busy line time and power will be saved when the air-current is continuous. But it is obvious that a continuous air-current cannot traverse a main line and a branch line *at the same time*. The problem then of operating switches and preserving the continuity of the air-current is a most important one. The solution of this problem belongs, without doubt, to Mr. Clay, and in the so-called valve attached to his system we find the only means yet devised of accomplishing all the objects aimed at. The Clay valve is an apparatus designed to shut off or divert the air-current, but to allow a carrier to pass through. The carrier opens the valve by striking a bell-crank, which raises a gate: the carrier passes through, and the gate is instantly closed by a combination of buffer and spring. One of these valves is placed in the main line just beyond each switch. The air-current thus makes a "loop" at each branch or substation, and returns into the main line on the other side of the valve mentioned. A carrier going to a station beyond passes through the valve, is seized by the air returning from the station, and proceeds on its journey. A valve is also placed just before the delivery of the carrier. The carrier passes through, and is dropped into a basket, but the air returns to the main line. Still another valve is

so placed as to allow a return carrier to be started on its journey towards the central office by using the "loop" current until it reaches the main return tube.

The Clay system has been adopted by the Postmaster General for the pneumatic line now in process of construction in Philadelphia, upon the recommendation of an investigating commission.

Some of the many advantages claimed for pneumatic transmission are almost self-evident.

First, Speed. Pneumatic dispatches are now delivered daily in the principal cities of Europe in less time than telegraphic messages.

Second, Accuracy. Pneumatic messages are delivered in the handwriting of the sender, and are not subject to errors of transmission or of oral reception.

Third, Fullness. There is no limiting of words.

Fourth, Privacy. Sealed letters may be sent.

Fifth, Economy. This is sufficiently demonstrated by the long and continued use of tube-lines by the European postal authorities, and by the Western Union Telegraph Company.

Some general considerations concerning pneumatic transmission may be mentioned, as follows:

The amount of power is that required to move a given weight a given distance.

The power is measured by the difference between the atmospheric pressure and the pressure in the tube, modified by friction, which is less in larger tubes.

The diameter of tube depends on the nature of the service, and on the economy of construction and operation. The amount of air at given pressure (or rarefaction) required to fill a tube increases as the square of the diameter of the tube.

With given pressure and diameter of tube, the speed is (under usual conditions) inversely as the length of the tube. With given pressure and length of tube, there is greater speed in large than in small tubes.

It is easily demonstrated that the movement of an air-current by compression is very much more economical than by rarefaction in increasing ratio as the difference increases between the atmospheric pressure and the pressure in the tube.

THE TIMBER PROBLEM IN THE SOUTH.

By Charles Mohr.

THE rapid exhaustion of the once extensive white-pine forests in the northern Atlantic States and on the borders of the Great Lakes, referred to in my paper in the December number of this Magazine, has led many capitalists and operators in the lumber industries in those sections to seek new fields for their work in the virgin pine forests of the South. There, too, disregard for the future of the timber supply has had the effect of lessening the resources of the forests, until the probability of their exhaustion within a comparatively short period must be acknowledged, unless different methods can be made to prevail. For the past quarter of a century the pine forests east and west of the lower Mississippi have been accessible by means of great railroad lines, resulting in the steady development of the lumbering industries to a much greater extent than can ever be met by the natural recuperation of the forests.

The South to-day contains more or less continuous forests of heavy-timber pines, extending over thousands of square miles. Of the five species of pines valuable for their wood, the long-leafed pine (*Pinus palustris*), the short-leafed pine (*Pinus echinata*), and the loblolly-pine (*Pinus Tæda*) furnish the immense supplies in this section of lumber and square timber, both for domestic purposes and for export. These are all of a gregarious habit, and either alone, or largely in excess of the hardwood growth with which in some sections they are found associated, form the forests referred to. Easily as the specific differences in these three varieties of pine may be recognized on close observation, there exists among people in general the greatest confusion in regard to the identity of each, while a similar misconception of the differences in quality of their lumber prevails among millmen, engineers, and architects.

Among these Southern pines the long-leafed pine—generally known as Southern yellow pine, or hard yellow pine and also named Southern pitch-pine, and Longstraw pine—takes the first place in economic importance on account both of its having the widest distribution and the qualities of its timber. In the latter respect it can safely be asserted that this tree is not surpassed by

any of the numerous species of the same genus found on this continent or elsewhere. In strength, elasticity, and resistance to atmospheric influences the timber of the long-leafed pine has no superior in fitness for heavy constructions. It is the tree which forms the source of the timber wealth along the great coast pine-belt, from 60 to 150 miles in width, extending from the southern confines of Virginia to the lower half of the peninsula of Florida, and along the coast of the eastern Gulf region to the bluffs bordering the lowlands of the Mississippi river. West of the Mississippi this belt reappears on the drift-covered uplands rising above the delta from the Ouachita river to the basin of the Trinity river in Texas, its highest limits scarcely passing beyond 32° North latitude. Before the dawn of the era of Southern industrial progress, which during the past decade has made such wonderful strides, the pine-belt of the Atlantic and Gulf States offered no inducements for the raising of crops, and only an insignificant proportion of its area was claimed for tillage. Considerable tracts of timber land had been despoiled of their growth, east of the Mississippi, for the sake of the resinous products of the long-leafed pine, but the forests were only slightly drawn upon to supply the home trade and a limited foreign demand,—chiefly for heavy spar timber. The pine forests west of the Mississippi river, practically inaccessible to industrial enterprise, remained in the primeval wilderness state.

The development of the timber resources in the Southern States dates from the opening of the railroad lines connecting the seaboard with the great centers of the North, effected chiefly between 1870 and 1880. During the latter year an attempt was made while the investigations of the forests of the United States for the Tenth Census were in progress, to estimate the merchantable timber standing in the Southern pine forests. If the difficulties in the way of obtaining trustworthy statistics in this case are considered, the results arrived at, with cautious conservatism, must be looked upon as mere approximations, falling in most instances below the limits of truth. In North Carolina the amount of merchantable timber remaining in the forests of the long-leafed pine in 1880, exclusive of the timber tapped for turpentine, was estimated at 5,229,000,000 feet, board measure. The cut for the same year was stated at 108,411,000 feet, of which about one-third was exported from Wilmington. A considerable proportion of the timber shipped northward by rail under the name of "North Carolina pine" is derived from the short-leafed pine and from the

loblolly-pine, the latter largely of second growth. The resources of South Carolina, according to the same Census, exceeded but little those of North Carolina, the cut having been estimated at 124,492,000 feet. In 1887 fully 73,000,000 feet were shipped by rail to the North, and 32,672,755 feet by water from Charleston, the export from that port rising in 1889 to 50,532,000 feet. In Georgia, the great pine State of the southern Atlantic region, the long-leafed timber standing in the forests, covering about half of the area of the State, was estimated at near 17,000,000,000 feet, with a cut of about 273,000,000 feet. From official returns obtained at short intervals, during the following ten years, from Savannah, Darien, New Brunswick, and points of minor importance, it is evident that the pine lumbering industries in Georgia have made slow progress. The shipments to foreign and domestic ports, and the small amount shipped by rail, appear never to have exceeded annually 312,000,000 feet, board measure. The production of lumber in eastern Florida, from all that can be learned since 1880, has been constantly on the decline. In 1885 little over 38,000,000 feet were shipped from Jacksonville.

The greatest activity and progress in the development of timber wealth in the South has been in the States bordering the Gulf. By its geographical position the coast pine-belt in the Gulf region, east of the Mississippi river, commands unsurpassed advantages for the utilization of its great resources. Fronting the Gulf with its splendid bays and safe roadsteads, the facilities for export by sea leave little to be desired, and the great trunk-lines leading to the northern markets, eastward and westward, give speedy access to the great centers of trade and industry. Traversed by navigable streams, with numerous tributaries, by which logs from widely-distant points may be driven to the mill-sites around or at the ports of export, the tide-water region of this coast is not rivaled in its advantages to the manufacturer, while it is further favored by a climate which at no season of the year presents any obstacles to operations in the logging-camp or at the mill. In making the timber estimates for the Census of 1880 no trees were taken into account below the dimensions which constitute a log twenty feet long and squaring twelve inches of heart-wood, free from blemish. Only this class of timber, the best cull, was, in those early days, accepted generally at the mills. Since that time, with the introduction of the steam-equipped logging tram-roads and of the modern dry-kiln, which renders the sappy part of the timber little less

valuable than the heart-wood, the standard merchantable timber has been lowered to trees scarcely over twelve inches in diameter, bringing thus by far the larger number of trees into requisition, and including many which before had been rejected. Judged by such standard the figures given in the Census estimates of the merchantable timber long-leafed pine standing in 1880, as far as Alabama and Mississippi are concerned, according to my personal experience, have to be raised fully 75 per cent. Viewed in such light the merchantable timber standing, in the year 1880, in the long-leafed pine forests of these States would amount to somewhat over 53,000,000,000 feet.

From Pensacola, in western Florida, 328,135,000 feet, board measure, of square timber, hewn and sawn, and lumber were shipped during 1889. Of this output one-third, at the lowest calculation, was cut in Alabama and sawn at the mills on Perdido and Escambia bay. During the same year 100,000,000 feet were shipped to foreign ports and coastwise from Mobile, the port of export in Alabama. At a rough estimate not less than 125,000,000 feet were forwarded by rail from the mills situated on the railroad lines leading to northern markets. With the allowance of 110,000,000 feet of the timber cut in Alabama and sawn in Florida, the shipments of square timber and lumber would in the aggregate amount in this State to not less than 335,000,000 feet against the cut estimated in the Tenth Census at 245,000,000 feet. According to the annual statement of the Board of Trade of Mobile, 119,748,000 feet were exported by sea from this port in 1892. With no less activity are the lumbering industries, depending upon the long-leafed pine, carried on in Mississippi. The cut in that State during 1880 was stated at 108,000,000 feet. From returns obtained at the chief points of trade and industry the shipments by water and by rail rose steadily until, during the year 1891, they reached nearly 300,000,000 feet. Altogether the output of the mills situated within the long-leafed pine region in the Gulf States east of the Mississippi can be said to have reached during the past year not less than 751,000,000 feet, exclusive of the home consumption.

In western Louisiana and eastern Texas the forests of long-leafed pine extend over an area exceeding 10,000 square miles. The merchantable timber standing in this area was estimated in 1880 at 42,000,000,000 feet, board measure, a figure that accords well with the average of 7000 feet to the acre assumed by millmen

and timber experts after years of experience. The annual cut is fairly represented by the shipments from the mills, reported for the year 1890-91, by the leading firms engaged in the business, at 800,000,000 feet. Of this output 225,000,000 feet have to be ascribed to Louisiana, with the chief seat of manufacture at Lake Charles, and of late at Alexandria, and 575,000,000 have been shipped from Beaumont, Orange, and the mills on the Sabine Pass and Eastern Texas railroad, in Texas. Nearly all of this output finds a market in St. Louis, Kansas City, and Omaha, in supplying the timberless region of the northwest.

The short-leafed pine, or yellow pine proper, also known as soft yellow pine, is, north of the long-leafed pine belt, an important factor in the lumbering interests of the Southern States. East of the Mississippi river this tree takes a subordinate position among the hardwood growth of the upland forests. There it furnishes chiefly the supplies for a home demand in the construction of dwellings and finishing work, for which it is admirably adapted. Only a small fraction of the cut is shipped to more distant markets. West of the Mississippi river, in the northern part of Louisiana, northeastern Texas, the larger part of Arkansas, and, to a small extent, in the eastern border of Indian Territory and in southern Missouri, the short-leafed pine prevails largely over the deciduous-leaved trees, forming mostly continuous forests over many hundreds of square miles. The Tenth Census estimated the amount of merchantable timber in 1880 in these western forests of short-leafed pine at 87,000,000,000 feet, board measure, exclusive of the forests in Missouri and the Indian Territory. In southern Missouri these forests are confined to the rocky hills of the Ozark mountains. The principal locations of the lumbering industry are in the valley of the Current river, and along the Memphis, Fort Scott and Kansas City railroad, with an annual output of about 310,000,000 feet, board measure. In Arkansas the short-leafed pine occupies the undulating uplands, the adjoining flat woods consisting almost entirely of the loblolly-pine. The timber of both species, sawn indiscriminately, is placed on the market as "Arkansas yellow pine." Not less than 560,000,000 feet of this yellow pine has been shipped during the past twelve months.

In northwestern Texas, from the valley of the Red river to 32° North latitude, bounded on the west by the prairie region, and in the adjoining part of Louisiana, the short-leafed pine forms almost exclusively the high forest growth. The timber resources

of the short-leafed pine belt are but little inferior to those of the forests of the long-leafed pine. The principal center of the lumber trade and manufacturing interests is Texarkana. According to the leading men in the business there, not less than 200,000,000 feet of lumber are annually sawn in Texarkana and its vicinity, and 105,000,000 feet have been shipped by the mills situated between that city and Marshall, in eastern Texas. In the light of this information the shipments of short-leafed pine timber from these western forests (inclusive of the loblolly-pine of Arkansas) amounted in 1891 to at least 1,300,000,000 feet. Almost the whole of this output is shipped to supply the markets of the Northwest. Trees of even less than twelve inches in diameter being cut here for the mills, and the scanty remainder being left unprotected against destruction by fire, there is no prospect for the restoration of the resources of these forests and their perpetuation.

The cypress, the giant among the trees of the forest in the eastern part of this continent, has been for the past few years coming more prominently to the front as a timber tree of importance. This tree is found most abundant in the deep swamps and shallow lakes of the Mississippi delta, and also in the alluvial swamps bordering the larger rivers in western Florida, and to a lesser extent in Alabama. It is also met in similar localities in the coast region of the southern Atlantic States. Scattered in the swamps, inaccessible by ordinary means, any attempt to make an estimate of their hidden wealth must be futile. Large bodies of cypress timber of the largest dimensions exist in the swamps of the lowlands on the banks of the Appalachicola river. About 10,000,000 feet, board measure, have been sawn annually, of late years, at the mills at Appalachicola, Fla., and shipped to northeastern markets. The swamps along the lower course of the Tombigbee and Mobile rivers still furnish a full supply for the shingle mills at Mobile, with an output of 175,000,000 pieces during the business year just passed. In the State of Mississippi the cypress brakes in the alluvial lands between the Yazoo and the Mississippi rivers contain a wealth of the finest timber, which for the greater part remains yet untouched by the axe, unavailable on account of the difficulty in reaching it. Considerable quantities of cypress timber are rafted on the Yazoo and Mississippi rivers to the mill sites at Greenville, Vicksburg, and New Orleans. Extensive cypress swamps exist on the Arkansas side of the Mississippi river. Southern Louisiana is rich in cypress timber. No less than sixty-

eight townships have been pointed out by parties interested in the subject between Lake Pontchartrain and the embouchures of the Atchafalaya river, which are roughly estimated to embrace 1,500,000 acres, more or less under cover of the cypress. It has been estimated that during the past twelve months about 175,000,000 feet, board measure, of lumber and 4,750,000 cypress shingles have been shipped from these districts, yet the manufacture of cypress lumber is in its infancy. Large investments are now being made in the cypress lands of the Southern States, and doubtless within the next ten years capital will make their resources available, even where access to them is not now considered feasible. With the exhaustion of the present resources of the cypress swamps it is to be feared that they will remain forever extinct. Under the altered conditions consequent upon the removal of their original tree growth, there will be neither room left nor time allotted for the development of this noble and valuable timber tree.

The red cedar, the tree of widest distribution in the United States, attains only in the mild and humid climate of the Gulf region its highest perfection in timber growth and its best adaptation to industrial uses. The finest quality of red cedar, fitted particularly for the manufacture of pencils, is found in the damp forests near the Gulf shore, in the upper part of the peninsula of Florida. The small remnant of the red cedar supplies is in the hands of a few, and for the want of further material to work upon a number of cedar mills have been compelled to close. In the valleys and coves in the basin of the Tennessee river, in Alabama, considerable quantities of this timber are yet found, and large supplies have been drawn from this section within recent years to serve for telegraph-poles and for piling, the best qualities being used for pencil-wood and in the manufacture of fine woodenware. The timber from the cedar brakes of Tennessee is for the greatest part fit only for inferior uses. Smaller supplies of fine cedar are found in isolated localities in the Red river valley, in northern Texas. The white cedar—or juniper, as it is known in the Gulf States—inhabits the black oozy swamps of the coast region. In greatest abundance it existed in the Dismal swamp in southern Virginia and North Carolina, and from these States chiefly the timber is furnished which is consumed in the manufacture of hollow-ware in Richmond and other Atlantic cities. In western Florida and eastern Alabama the juniper swamps have been largely stripped of the best quality of their timber. The tree, however, is found in sufficient quantities

to supply the demand for its valuable timber for some time to come.

The facts disclosed by the investigations of our Southern pine forests, and the management of their timber resources, cannot but lead to the conviction that we have already entered upon an era involving their complete extinction. Stupendous as these resources appear, as illustrated by the figures quoted in this paper, any doubt about their depletion within a comparatively brief period will be removed if, on the other hand, those figures are considered which relate to the ever-increasing draft upon the forests. No one is more aware of the inevitable result of the present treatment of these forests than those actively engaged in reaping the harvest of timber, to mature which nature required centuries of time. There is no need to dwell here on the calamities which would follow the extinction of the industrial and commercial interests connected with the forests, upon which so many thousands of our people are dependent for their existence, or to contemplate the evil consequences of the destruction of the high forest, over large areas, in affecting existing conditions of climate and soil. These themes have become truisms, which in our day can escape no one taking an active interest in affairs affecting our material welfare. Still, with all the light afforded by science and the teachings of national economy, there exists a popular disregard for matters pertaining to forestry, and little headway has been made in the attempt, through State action or otherwise, to secure to posterity some of the advantages of the forest wealth now enjoyed in this country and considered so indispensable to our prosperity.

Certain it is that the preservation and economical management of the forests is beyond the power of private efforts, aiming necessarily rather at the promotion of the interests of coming generations than tending to contribute to the profits of the present. This period of Columbian celebrations is particularly opportune to induce reflections bearing upon this problem, and to remind one of the time when this new world, robed in the garb of its virgin forests, was opened to afford happy homes for the toiling masses in the old world. Proud as we have cause to be of the achievements of our time, and of the glorious success in the struggle for their attainment in our country, it must not be lost sight of that in the heedless despoliation of the inheritance bequeathed to us in its forests a danger has been invoked which threatens to arrest the flight to that acme of national prosperity to which we are aspiring.

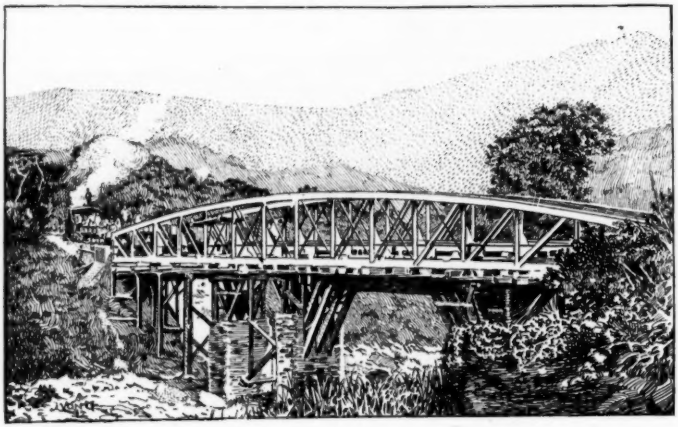
RAILROAD DEVELOPMENT IN AFRICA.

By Cyrus C. Adams.

MANY people said, five years ago, that Caucasian activity in Africa was a mere crazy impulse, an illogical scramble impelled by sentiment instead of common sense and destined to early subsidence. That sort of talk can come now only from those who are ignorant or reckless of language. Africa is not an El Dorado; but he who now has the temerity to say that great good cannot come out of "the Dark Continent" may be covered with confusion by the testimony of many observers who have lived there showing what there is in Africa that we should desire. Money is not going into African enterprises without consideration of the question whether, in the long run, it will pay. Before the Belgium Society of the Upper Congo invested a dollar in its Congo railroad plant it put a steamer and explorers on the upper river and, for a year, studied commercial possibilities. All over the newly-acquired territories, from the hills of German Usambara, near the Indian ocean, to the Oil rivers of the British Niger territory, specialists and men of practical sense are experimenting with various cultures, studying the extent of natural resources and the best means of developing them. Here and there they are training natives to work for wages, payable in cash. When governments and private enterprise, after years of inquiry, throw more money into Africa than ever, it is good evidence that there is something there worth the world's while. This is being done all over tropical Africa. Seven years ago even enthusiastic friends of African enterprise would have regarded as a mere visionary the man who advocated a railroad to the great lakes. All this is changed. In December last the map of the complete preliminary survey for the British railroad from the Indian ocean to Victoria Nyanza came to hand. The engineers announce that they have surveyed several routes from Mombasa to Victoria Nyanza, and they have found a route that is both practicable and not costly. Moreover, men of the highest authority testify that the railroad is essential now and will in time be profitable.

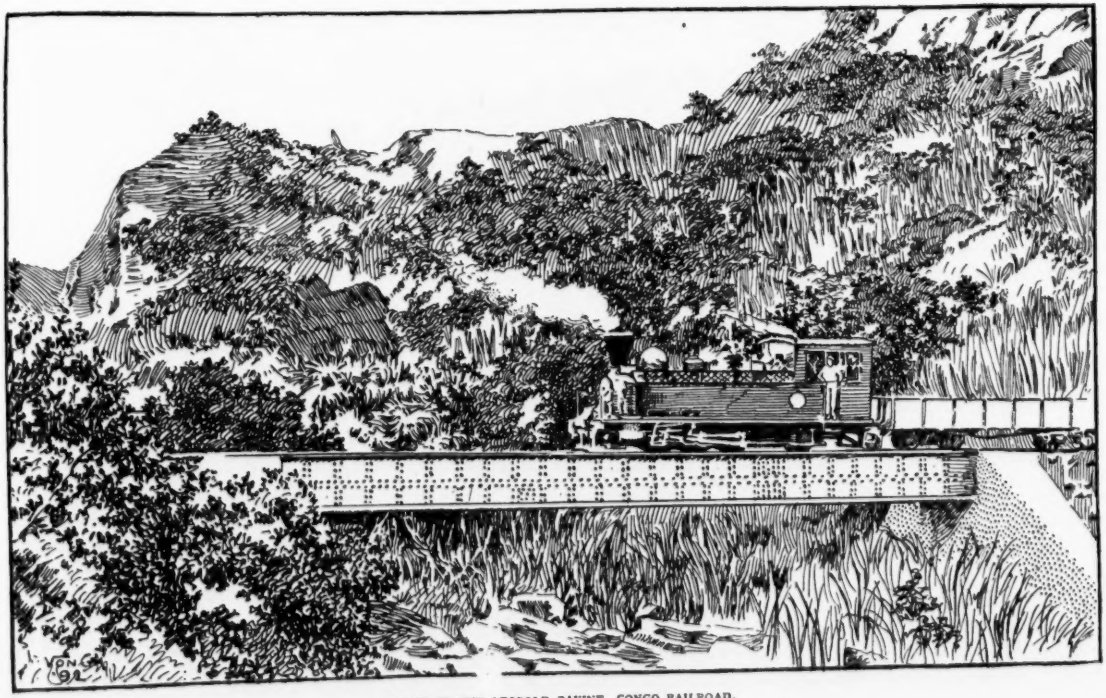
In the following summary of facts relating to the remarkable impetus recently given to railroad construction in Africa only those

projects will be mentioned that are under way, or have been duly authorized and seem certain of fulfillment. Allusion should be made, however, to the schemes for stretching a railroad across the Sahara. While still in the air, it is quite certain that something will come of the recent agitation in France and Algeria in favor of a trans-Saharan railroad as a strategic, political, and commercial necessity. We know that the French have made Algeria one of the best mapped parts of the world, that they have built 1700 miles of railroad in the colony, and that Algeria is looking across the desert to the rich central and western Soudan as a source of trade, capable of enormous expansion, which may be drawn to her



BRIDGE IN THE MPOSO VALLEY, CONGO RAILROAD.

marts. The outline of the plan is to build a narrow-gage road from southern Algeria through a series of oases to Timbuktu, and to connect this point by rail with Senegambia on the southwest and on the east with the fertile regions of the central Soudan as far as Lake Tchad. Three projects for this railroad have been studied by order of the French government. These proposed routes, with the project for a shorter line, having an ocean terminus at Cape Nun, are indicated on the map which accompanies this paper. The Russians have proved in central Asia that desert-railroad building is practicable; and while the Saharan railroad project has not yet passed the stage of inquiry and discussion, there are indications that the work of carrying it into effect will



BRIDGE IN THE LEOPOLD RAVINE, CONGO RAILROAD.

not be long delayed. It will be first required, however, to establish proper influence over desert tribes like the Tuaregs, who seem at last on the verge of more hopeful and pleasant relations with the white race. The proposed line from Ain Sefra is in great favor, and is likely to prove most practicable.

There is no immediate prospect of the further extension of the Nile railroad beyond its terminus at Girgeh, to which it will soon be completed, 300 miles from Cairo; or of carrying forward the proposed line between Suakin on the Red sea and Berber on the Nile, several miles of which were graded early in the

MATADI HILL.
[Before grading for the Congo railroad.]

British campaign against the Mahdi. These are projects of the future, desirable and practicable only when the Egyptian Soudan and its splendid resources are again open to the world. When that time comes, the Suakin-Berber route is certain to be built. Further south, at Massowah, is the little line, sixteen miles long, which the Italians built from the sea to Saati during their campaign against King John, and trains still climb the rather heavy grade to the foot of the lofty wall that bounds the great Abyssinian plateau. Next we come to one of the great enterprises that are to link central Africa with the sea by iron bands.

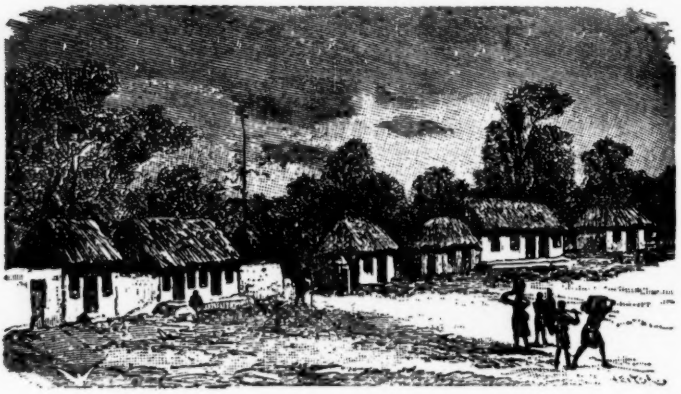
Africa has the name of a land with great extent of coast-line and few good harbors. But the continent is not quite so badly off for harbors as was supposed. Such fine harbors as that of Beira are among recent discoveries. Other natural ports, it has been found, may be adapted, without enormous expense, for the purposes of ocean steamers. Mombasa, the principal port of the Imperial British East Africa Company, is destined to be one of the greatest towns of East Africa. Ten years ago a squalid collection of Arab houses and native huts, the town to-day has commodious public buildings and residences, widened streets, and sanitary improve-

MATADI HILL.
[After grading for the Congo railroad.]

ments. It is to be the starting point of the railroad—about 550 miles long—that is to join the northeast coast of Victoria Nyanza with the sea. The British government assisted the company to make the survey, which has occupied nearly a year. Captain Pringle, of the survey corps, has returned to England with a map of the route. It was feared that the ascent of the formidable Mau escarpment, over a hundred miles east of the lake, would involve large expense. A route was found, however, to the north of the small Lake Nakuro, where no escarpment or difficult gradient is met. The proposed route finally emerges upon the grass lands of the Mau plateau,

7000 to 8000 feet above the sea. It is here, under the equator but in a temperate climate, that Captain Lugard says he hopes to see the experiment of European colonization tried. Thence the route descends to the Kavirondo plain and the lake 3900 feet above the sea.

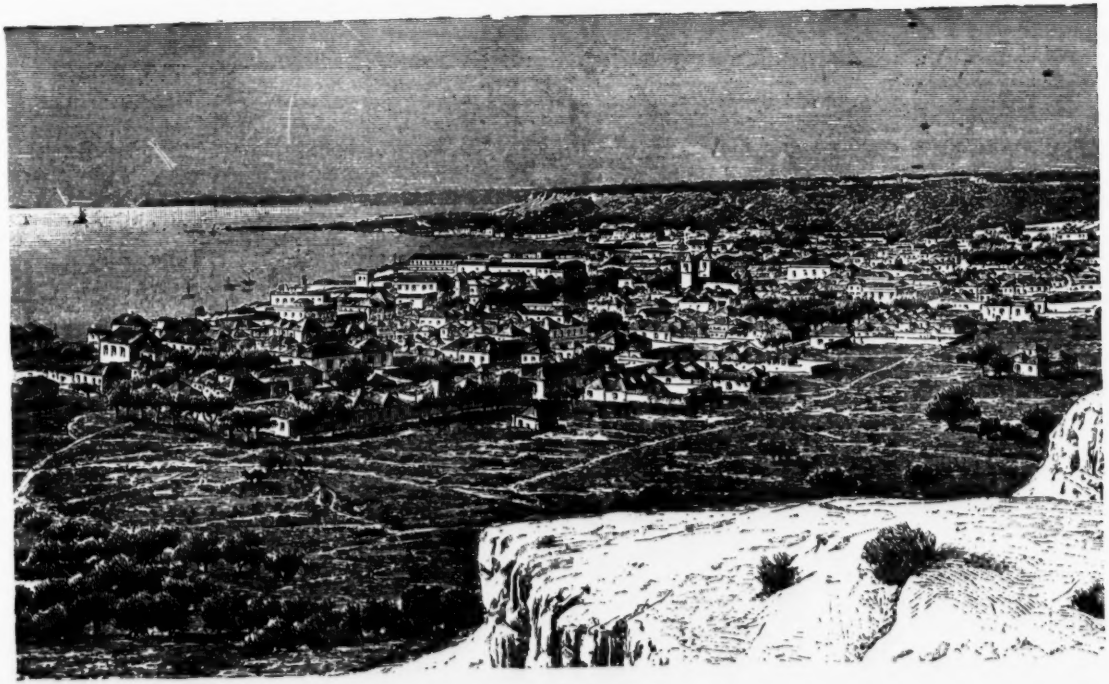
The cost of the Mombasa-Victoria Nyanza railroad is roughly estimated at about $12,000,000, but the company's capital is inadequate for this expense. When it announced its intention of retiring from Uganda in March next, such a protest went up against abandoning the country that the Government was impelled to take steps which will doubtless result in its assumption next spring of the government of regions bordering the northern part of the lake. Freight-



A STREET IN MALANJE.
[Projected eastern terminus of the Angola railroad.]

carriage between the sea and the lake now costs sixty-five cents a pound, and the productive and populous lake countries are worthless, commercially, until this railroad is built. The question has been exhaustively discussed in all its bearings; the business sentiment of England seems decidedly to favor the railroad enterprise; and there is every prospect that the building of this road under government auspices will be one of the next great steps in the progress of Africa.

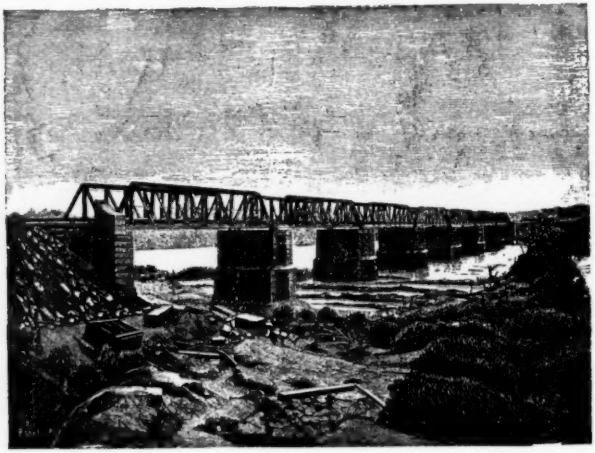
About ninety miles below Mombasa the Germans have started their first railroad enterprise in Africa. The route has been surveyed between the port of Tanga and the interior station of Magila, among the Usambara mountains, thirty-five miles from the sea.



VIEW OF ST. PAUL DE LOANDA.

[The chief town of West Africa and starting point of the Angola railroad.]

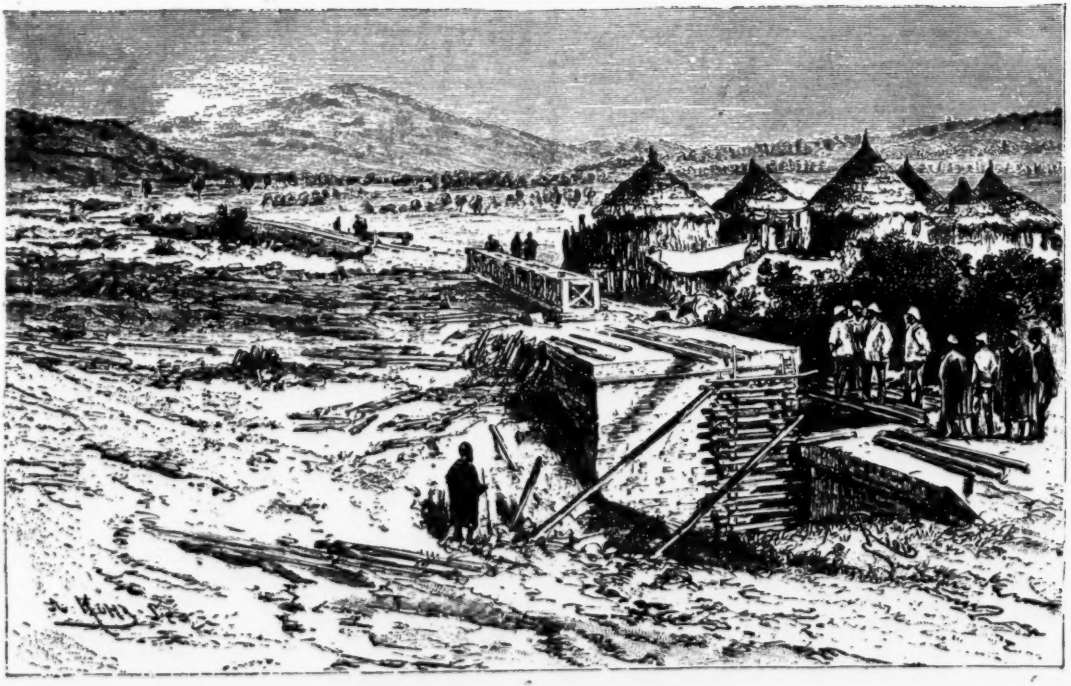
The railroad company, chiefly composed of capitalists in the German East Africa Company, appropriated $375,000 in October last to begin the work, and the contractors are now grading with the expectation of completing the road to Magila by the time the young coffee-plantations yield their first crop. Ceylon planters speak well of these coffee estates, and the experimental stage has been so successful that coffee-culture is to be largely extended. The plantation company is also growing tobacco as good as the best Sumatra product, and several hundred bales of excellent cotton have recently been shipped to Europe. No colony now seems to have a brighter outlook than that of the German East Africa



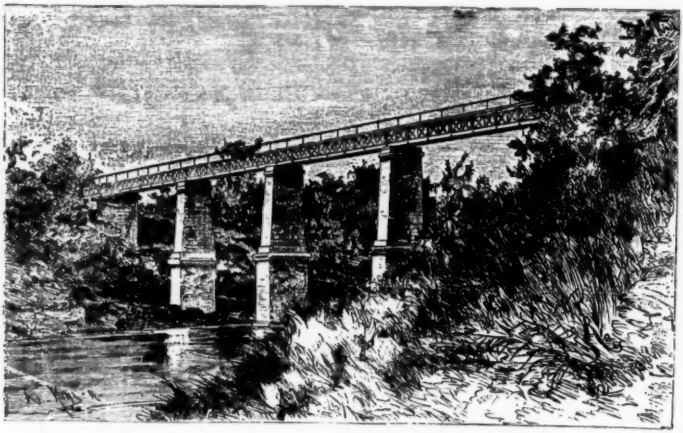
BRIDGE OVER THE INCOMATI RIVER.
[Delagoa Bay railroad.]

Company. The railroad now building is the first section of the proposed line to the beautiful country of Karagwe, which so inspired the enthusiasm of Stanley when he visited the southwest shores of Victoria Nyanza. The surveys are soon to be extended beyond Magila through the Usambara Mountains.

Only five years ago a magnificent harbor was discovered at the mouth of the Pungwe river, about 115 miles below the Zambesi delta. It is about two miles wide and six miles long, and on its northern shore has arisen the town of Beira, where 500 Europeans, half of them British, are now living. Beira is one of Africa's latest marvels. Probably no white man, six years ago, had ever seen the



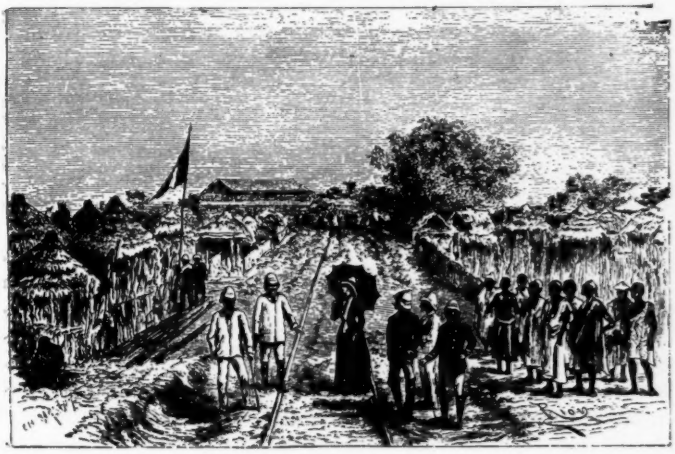
LAYING TRACK ON THE SENEGAL RAILROAD.



THE GALLIENI VIADUCT, SENEGAL RAILROAD.

barren promontory of sand it occupies. On November 28, 1892, a locomotive that had been put together in Beira puffed through one of the streets and a little way out of the town; for Beira is to be the port of Mashonaland, the region of mountain and plateau where British enterprise is opening new gold-fields. A month ago thirty-five miles of the railroad had been completed. The route for nearly half the way to Massi Kesse lies along the Busi river. Its total length is less than 200 miles, its longest bridge has a span of about 300 feet, and the cost of the road is estimated at about $5,000,000. The Mozambique Company, a Portuguese corporation, is carrying out the work, but by arrangement the British South Africa Company is to have certain privileges in the management of the road and will build an extension from the Portuguese frontier at Massi Kesse to Fort Salisbury, the seat of government in Mashonaland. The Portuguese line is to be completed by the end of this year, and then the British extension will be pushed forward. This line will give to Mashonaland—which in agricultural and mineral resources and the salubrity of its climate is one of the most favored parts of Africa—its shortest outlet to the sea. Beira is destined to be a port of large importance, and lots for business purposes are now selling for $1500 to $2500 a piece, in a place which not many months ago was a barren waste. Five years ago only two or three white men had ever visited Mashonaland; its present population includes 3000 white settlers.

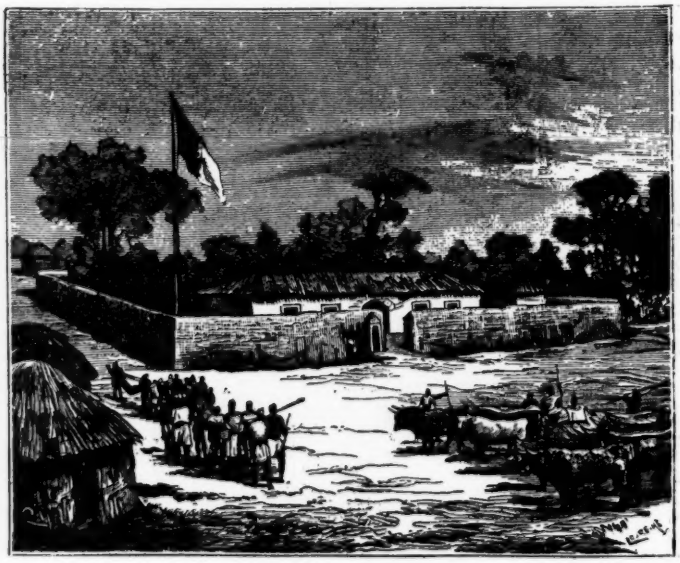
The best harbor in East Africa is Delagoa bay. It could without great expense be made accessible to the largest ocean vessels. On a tongue of land jutting into the bay is the town of Lourenço Marques, whose name has been familiar as the starting point of the Delagoa Bay and East African railroad completed to the Transvaal frontier, fifty-seven miles, in 1887. The South African Republic, according to its agreement, is extending this line 200 miles further west to Pretoria, and the road, the first to enter the Boer state, is now about forty miles within the Transvaal territory, with a branch running to the large mining center at Barberton. The Netherlands Company, in charge of the work, has just secured from the Rothschilds a loan that will suffice to complete the line to Pretoria. Like all railroads in the newer parts of Africa, the Delagoa bay line is narrow-gage, but it is superior to any other African line within or near the tropics in solidity of construction and the quality of its equipment. Johannesburg, the great mining-center of the Witwaters Rand, is really the goal of ali South African railroads. It lies more than 6000 feet above the sea, and the grades from Delagoa bay, the shortest route to the town, are in places very heavy. The United States and Great Britain have not yet entirely settled their dispute with Portugal over the claims of the American builder of the Portuguese section and the English stockholders in the enterprise.



LAYING LAST RAIL ON THE FIRST SECTION OF THE SENEGAL RAILROAD.

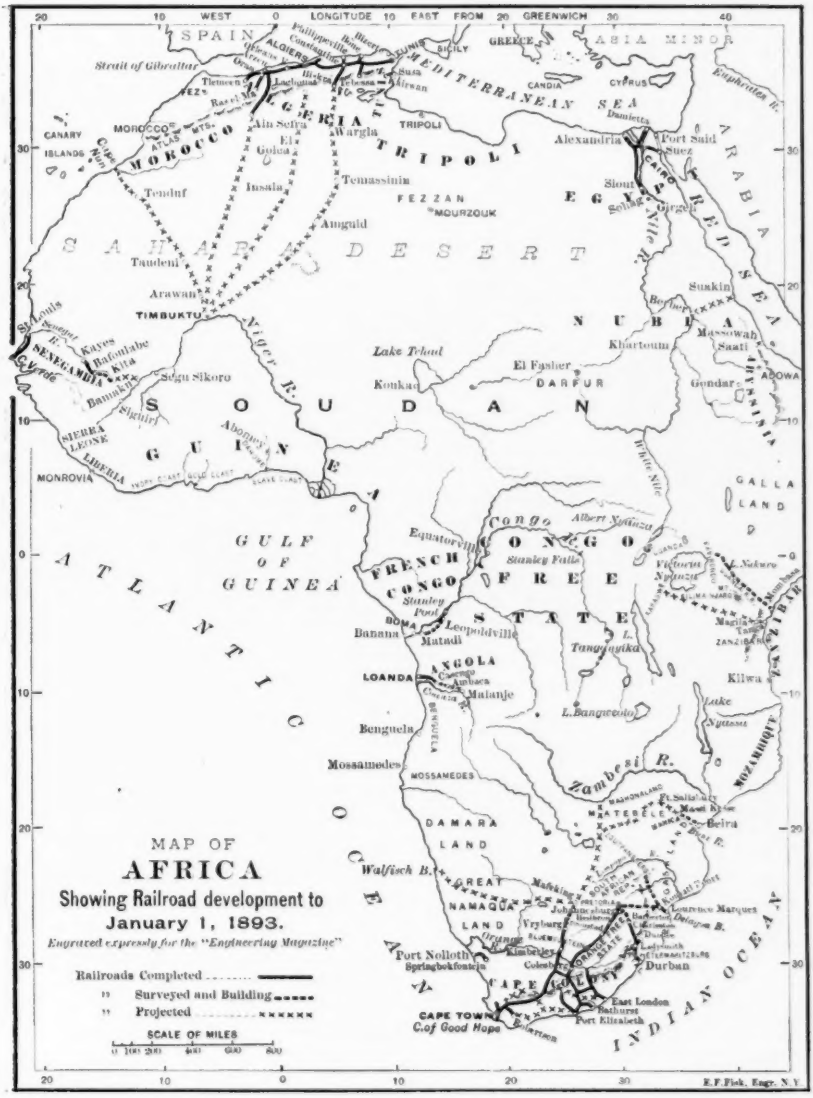
In December last the first sod was cut at Komati Poort on the Delagoa bay railroad for the northern line, which is to run for 200 miles a little west of north through the Salati gold fields to the mines in the Zoutpansberg, not far from the northern edge of the South African Republic. This enterprise is to be vigorously pushed, and there is already talk of extending it ultimately to Mashonaland.

It is not the purpose of the writer here to trace the development of the railroad in the domain of civilized South Africa. The map



PORTUGUESE FORT AT MALANJE.

shows the present extent of Cape Colony lines, where 8000 miles of road are now in operation. It is interesting to note that the main line through Natal, from Durban, through Pietermaritzburg, has just been completed to Charleston on the Transvaal frontier. This road is certain to be extended to Johannesburg and Pretoria. Negotiations with the Transvaal government for the survey for this extension are in progress. The Cape, however, has beaten Natal in the race for Transvaal trade by being the first to reach the Boer capital. The whistle of the Cape locomotives was heard in


MAP OF
AFRICA
Showing Railroad development to
January 1, 1893.
Engraved expressly for the "Engineering Magazine"
Railroads Completed
" Surveyed and Building
" Projected
SCALE OF MILES
E.F.Fisk, Engr. N.Y.
LONGITUDE FROM GREENWICH
WEST
EAST
SPAIN
ALGERIA
TUNIS
SICILY
GREECE
ARABIA MINOR
MEDITERRANEAN SEA
CANDIA
CYPRUS
Strait of Gibraltar
MOROCCO
CANARY ISLANDS
TRIPOLI
Alexandria
Port Said
Suez
CAIRO
EGYPT
RED SEA
ARABIA
SAHARA DESERT
FEZZAN
MOURZOUK
Ghadames
Tendut
Araouan
TIMBUKTU
Taudeni
Insala
Temassinin
Aoudjeli
Sokna
Siout
Assiout
Girgeh
Nile R.
Suakin
NUBIA
Berber
Massowah
Khartoum
Saati
ABOWA
Gondar
ABYSSINIA
Lake Tchad
El Fasher
DARFUR
Konkaq
SOUDAN
Kayes
Bafoulabe
Kita
Bamako
Ségu Sikoro
Niger R.
White Nile
SENEGAMBIA
SIERRA LEONE
LIBERIA
MONROVIA
GUINEA
GALLA LAND
Albert Nyanza
Victoria Nyanza
L. Nakuro
Equator
CONGO FREE STATE
FRENCH CONGO
Stanley Pool
Stanley Falls
Leopoldville
Banana
Matadi
BOMA
L. Tanganyika
ZANZIBAR
Kilwa
LOANDA
ANGOLA
Caconda
Ambaca
Malanje
L. Bangweolo
Lake Nyassa
Benguela
Mossamedes
MOSSAMEDES
Zambesi R.
MOZAMBIQUE
Beira
DAMARA LAND
Walfisch B.
GREAT NAMAQUA LAND
Orange R.
Port Nolloth
Springbokfontein
Kimberley
Durban
CAPE COLONY
CAPE TOWN
C.of Good Hope
East London
Bathurst
Port Elizabeth
Algoa B.
Delagoa B.
Lourenco Marques
GULF OF GUINEA
ATLANTIC OCEAN
INDIAN OCEAN

Johannesburg several months ago, and communication by rail between Cape Town and Pretoria was opened in December last. The slow and unprogressive Boer long fought the invasion of railroads from the South, but he has been compelled to yield to the resistless progress of events.

Late in 1890 about 2000 workmen were engaged upon the most remarkable railroad enterprise in Africa. It was the extension of the line from the Kimberley diamond mines, north through the wastes of British Bechuanaland, where Livingstone began his missionary career. Trains are now running to Vryburg, the capital of the province, 130 miles from Kimberley. The road is being extended to Mafeking, 100 miles further towards the Zambesi. The intention is ultimately to push the line north to the Zambesi, with a branch northeast from Mafeking to Mashonaland, giving that region of gold and fertile uplands another outlet to the sea. Towns are rising along the line, of which Vryburg and Mafeking are the most promising. White colonists are moving into this region of undoubted resources, but the most sparsely populated part of Africa outside the Sahara. Representatives of all trades and professions are planting civilization in the wilderness. A project is on foot to build a railroad from Walfisch bay to Mafeking, 780 miles, thus saving three days of travel from Europe over the present Cape route to the Transvaal gold-fields.

When the first sod was cut on the Angola line, in 1886, the enterprise was announced, rather grandiloquently, as a scheme to cross the continent and unite with the railroad from Delagoa bay. More modest and practical ideas have, for the present, supplanted this project in the air. The Royal Trans-African railroad has now been opened from Loanda, a distance of 150 miles. Its destination is Malanje, though it will not reach Ambaca, on the way, for some time, and that point is likely to be its eastern terminus for many years. The natives take very kindly to the innovation, and a large number of them travel on the line. Commercially, however, the road will be of little service until it reaches Casengo, the center of the coffee district. The planters are eagerly awaiting it, for it will reduce by more than half the cost of transporting coffee to Loanda.

Perhaps the world is more interested in the Congo railroad than in any other African line, because the building of this road, only a little over 200 miles long, is all that is needed to make easily accessible 6000 miles of navigable highways to the very heart of

Africa. To-day the only products of the upper Congo that will bear the cost of transportation past the cataracts on the backs of men are ivory and india-rubber. Aside from its rubber product the future of the Congo basin can be assured only by the success of cotton, sugar, coffee, and tobacco planting. Plantations will be opened as soon as the railroad reaches Stanley Pool. It is easy to see what a dead weight upon enterprise is the present almost prohibitory charge of $200 a ton for carrying freight around the cataracts. The Company of the Upper Congo believes that the completion of its road will introduce a new era; and so for nearly two years it has been hopefully blasting its way through the toughest of quartzite along the hills that slope steeply to the river and up the Mposo ravine that bristled with engineering difficulties, until it has finally emerged upon the plateau beyond Palaballa and now has easy work before it all the way to Stanley Pool. More than 300 white men and 2000 natives are engaged in the undertaking, which will not be completed before 1895. It will cost, with its equipment, $6,000,000,—a million more than the original estimate. No railroad in the world is likely to be a more important factor for civilization than this short line.

The Senegal railroad, from Cape Verde to St. Louis, 164 miles, has the distinction of being the first line built in tropical Africa. Another line extends ninety-four miles from Kayes, at the head of navigation on the Senegal river, to Bafoulabe. Short as it is, the line, built by the French government, has been of great utility in the transportation of supplies and soldiers on their way to the French posts along the Niger river. The government, since the fall of 1891, has been conducting surveys for the extension of the road to Bamaku, on the Niger. The final survey has been made from Bafoulabe to Kita, and the preliminary studies have been extended to the terminus on the Niger. The second section of the road to Kita is to be built at once. It is estimated by the engineers that it will cost $3,000,000, and that four years will be required to build it. When the road reaches the Niger, there will be steam communication all the way between the civilized world and the famous town of Timbuktu.

All these enterprises are going forward under governmental auspices or in the hands of private companies fortified by liberal concessions and guarantees.

PRACTICAL FARMING BY ELECTRICITY.

By A. F. McKissick.

THE first requisite of a modern farm is that it shall be well equipped with a great variety of implements and machinery, without the aid of which scarcely any kind of labor can be performed. No argument is needed to show that the better these appliances, or the better suited to their purposes, the greater will be the profits it is possible to derive from farming. It becomes a matter of vital importance, therefore, that the farmer shall be able to select the best machines, and to apply the forces required for their use to the greatest advantage. Modern inventive talent has completely revolutionized the processes of agriculture, so that the work which once employed many hands, perhaps involving much drudgery, one person may now perform, through the aid of machinery, with little or no discomfort. Farming tools have become lighter and more efficient than formerly, the soil is plowed more deeply and with greater ease, planting is done better with mechanical helps than by hand labor, and harvesting and threshing have become child's play as compared with the heavy tasks which they once imposed upon the farmer.

The machinery required for the operation of a farm is costly, if considered in the aggregate. The cost of the machinery and implements now in use on American farms is estimated to have cost $1,000,000,000, while a like sum is estimated to be yearly paid for the labor of men and horses. As the employment of machinery on the farm increases, it becomes more and more necessary that economy should be used in its operation, which gives rise to the inquiry whether any motive power less expensive than that now in use can be utilized. The application of electricity to all industries is becoming so general that this agency is now wielding a more potent influence on our civilization than any other force known to man. Twelve years ago the electric light was a laboratory curiosity; now it is the most successful illuminant known. Six years ago the first attempt to apply this mysterious force to the propelling of street cars was made; now it is a question whether, in the next six years, the horse-car will not disappear altogether. Can we not apply this new source of power to some farming operations?

The advantage is conceded of concentrating several small sources of power in one large central station, power being supplied thence to these smaller units by means of electricity. This is the field that commercial motors have entered in our cities. A larger boiler and a larger engine must be used at this central station, which means less first cost per horse-power, more economy, greater efficiency, and a saving in labor, wear, and tear. In the central station only one source of water-supply is to be considered, the fuel is concentrated at this point, and one fireman does the work of eight or ten. There is thus at once a saving in fuel, in water, in wear and tear, in labor, and in the erection of buildings for engines and boilers.

It was this idea, and the absence from danger by fires, that caused the installation of the electric-power system at the farm of the Alabama Agricultural Experiment Station, located at Auburn, early in 1892. This farm is well equipped with the most modern agricultural implements, and it is the intention of the authorities to make it, as fully as possible, a model farm. The crops grown are cotton, corn, wheat, oats, barley, rye, sorghum, and some others. On every such farm there must be some source of power to be used for the operations of ginning and pressing cotton, threshing grain, cutting up feed stuff, etc. On this farm power was supplied formerly from a steam-boiler and an ordinary slide-valve engine. Situated as the farm is, right in the country, without waterworks and in a sparsely-settled community, a fire once started might prove very disastrous. A whole year's crop might be swept away by the work of one spark and the lives of valuable cattle lost. Diminishing this risk means a great deal to an isolated farm.

The boiler located on the college campus that supplies the mechanical and electrical laboratories is amply large to furnish the station with all the power required. So it was determined to do away with the engine and boiler at the experiment station, using instead a motor which could be supplied with current from the dynamo in the electrical laboratory used for lighting up the different buildings and for experimental purposes. The distance, very nearly three-quarters of a mile, seemed at first an objection, but when the advantages of the new system over the old were considered, this objection was forgotten. The 15-horse-power engine and boiler were sold, and a 10-horse-power motor installed in place thereof. The generator was a 125-volt, 84-ampere, compound machine. Circumstances were such that it was necessary

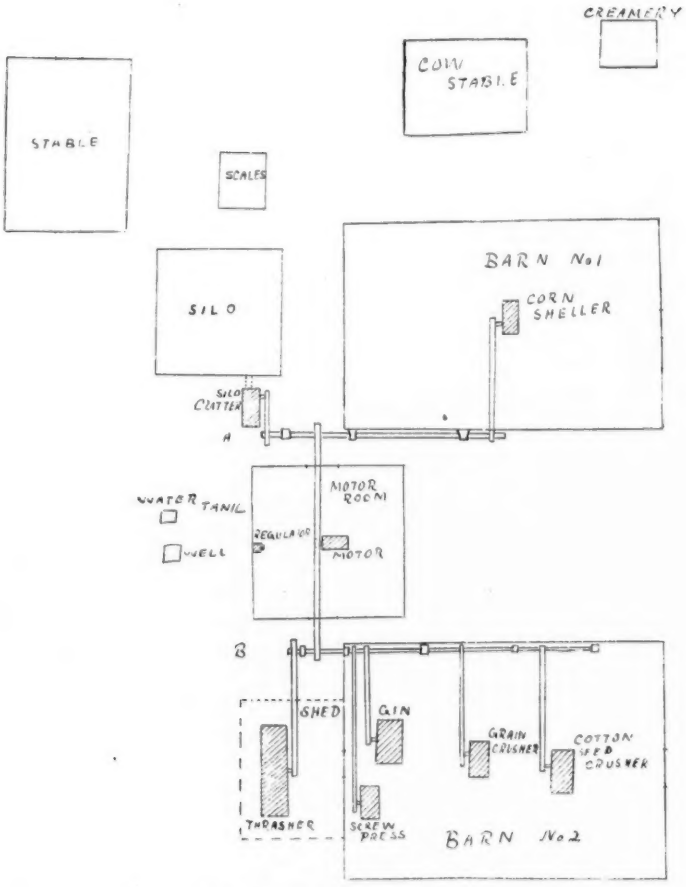


FIG 1.—PLAN OF MOTOR AND FARM MACHINERY.

to use this dynamo. On account of the rather low voltage for transmission of power, the wire used was necessarily large and rather expensive. If, instead of a 125-volt system, the standard voltage for transmission of power in cities (500 volts) could have been used, the copper wire would have cost only about one-fourth of what it did. However, as a 125-volt current is harmless, it was determined to use the earth for the return. It was found subse-

quently that the earth return had to be helped out with a No. 6 B. & S. wire. It then worked satisfactorily, and from the opening day—April 15, 1892—everything has gone on smoothly.

In an accompanying diagram is shown the arrangement of the motor and the machines it operates. The motor is located halfway between two lines of shafting (*A* and *B*), so that the same belt can be used to operate either line. The old engine-house is now used for a motor-room. The ensilage-cutter (shown in Figure 2) requires a very high rate of speed. Sharp knives cut up the green stalks of corn into small pieces, and an elevator running at

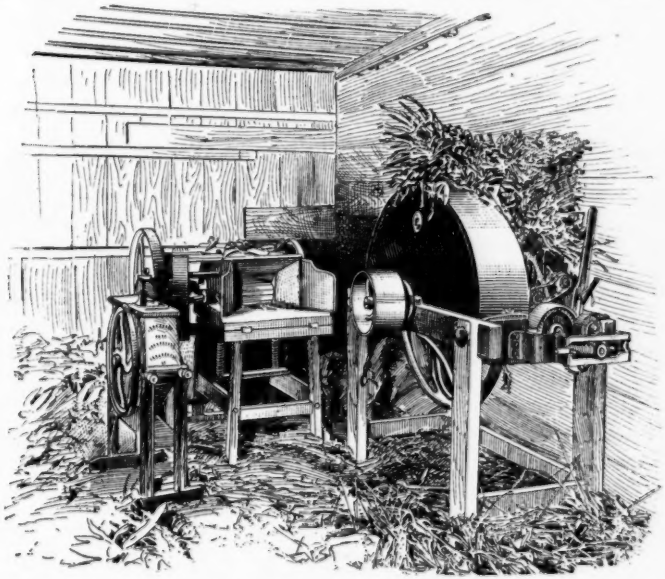


FIG. 2.—CORN-SHELLER AND SEPARATOR AND ENSILAGE-CUTTER.

the same time carries these pieces up into the silo, where they are firmly packed down, making one of the best feed stuffs for cattle.

Barn No. 1 is used mostly for storage of tools, fodder, and corn. The corn-sheller, located in this building, is seen also in the rear of Figure 2. Nearly all of the machines are as indicated, located in barn No. 2. The thresher (Figure 3) threshes out all the small grain grown on the farm. The cotton-gin is seen in Figure 4, and the screw-press, for baling cotton and hay, on the left. The feed-

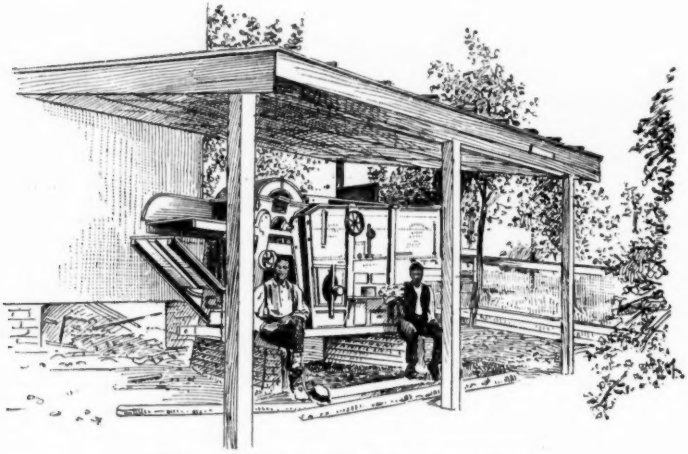


FIG. 3.—THRESHING-MACHINE AS RUN BY ELECTRICITY.

cutter (Figure 5) is a very useful machine on the farm. Figure 6 shows the cotton-seed crusher, for converting the seed into fertilizers. Figure 7 shows the motor and regulator. Figure 8 the compound generator which supplies the motor with current. In the rear is seen the arc-lighting dynamo, used for lighting the campus. Figure 9 shows a view of the line which was constructed by the students in electrical engineering, the college buildings looming up in the distance.

It is true that there is some loss in the line and in the generator and motor, and that with an efficient engine and boiler at the station a higher efficiency could be secured than by the system now in use. But when the advantages are considered, it will be seen that this loss in efficiency is more than compensated for. We do away with the services of a fireman at the station. It is true, there is one employed at the college, but it was necessary to have him there before this motor system was installed. Again, he keeps the boiler steamed up nearly all the time, so that the extra work of furnishing steam for one motor plant does not amount to much. Instead of hauling fuel to two places, only one is now supplied. Only one source of water supply is now necessary. A very great advantage is the protection from fires. A boiler in experienced hands is very nearly as safe as a tea-kettle, but in the hands of the laborer that is found generally on the farm it

would be far from safe. An engine, too, in inexperienced hands could not be kept up very long. The repair bills would run up to quite a sum in a year or two. On the other hand, the boiler and engine at the college are under the direct supervision of a skilled engineer and an experienced fireman. The motor is self-oiling and self-regulating, and needs little attention after it is once started. The generator and the engine are equally self-oiling and self-regulating.

Last year's crop of wheat, oats, rye ,and barley was speedily threshed out in June. Corn has been ground up to meet the demand, and the last cotton crop has just been ginned and pressed. The silo was filled during the latter part of September. The repairs so far amount to about fifty cents for raw-hide strips, used for sewing belts together. The repair bill of the engine and boiler formerly in use would have presented quite a different appearance. If at any time, in case of emergency, it is necessary to work at night, the current can furnish light. The station grounds and buildings can be easily lighted up from this dynamo. In fact it is intended to develop thoroughly every possible application, if there be any advantage in so doing. For instance, there are two large water-tanks, fed by hydraulic rams from the fish-ponds. During midsummer, when the water gets very low in these ponds, the tanks

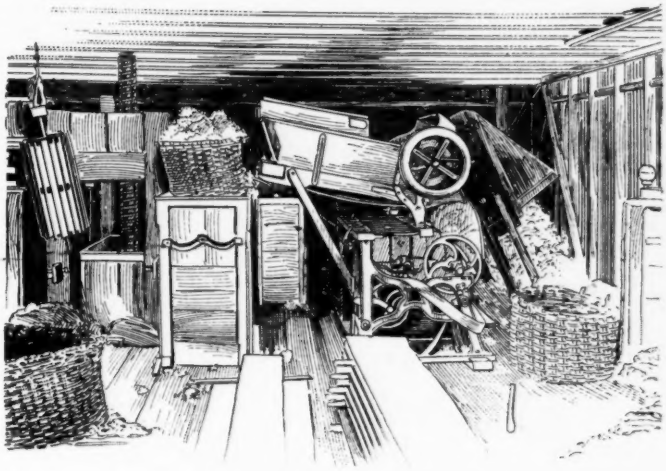


FIG. 4.—COTTON-GIN RUN BY ELECTRICITY.

are almost empty. It is designed to put in a pump to be run from the motor in order to fill the tanks with water from a well near by. As has been suggested, this pump could also be used for watering live stock, washing carriages and wagons, laundry purposes, and putting out fires. Another application that is intended is the running of the cream separator in the creamery, shown in Figure 1, with a one-horse power Crocker-Wheeler motor. There are many other machines, not in use at this farm, for which a great deal of power is needed. Some of these are hoists, churns, circular saws for sawing lumber, planing machines, lathes, sorghum-mills, and cider-presses. These could be easily run from one motor. So much has been done with the plant at this farm up to this time. The use of electricity for transmission of power for farming purposes is no longer an experiment.

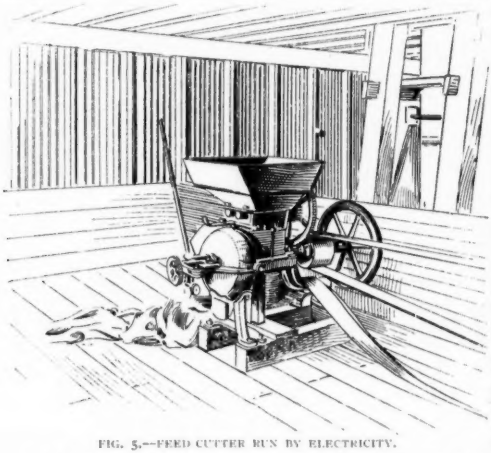


FIG. 5.—FEED CUTTER RUN BY ELECTRICITY.

As to the general application of this system much can be said. Let us compare this electric-motor system supplied with power from a central station with the single-unit system. That is, is it more economical to generate all our power in a central station, transmitting

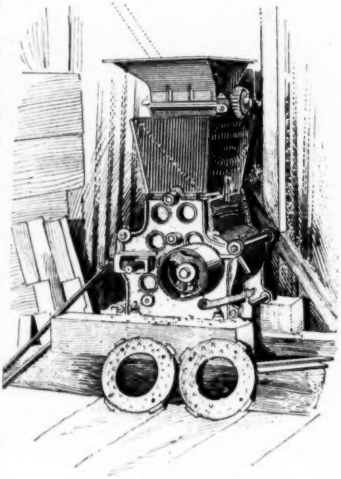


FIG. 6.—COTTON-SEED CRUSHER.

it to different sub stations by means of electricity, than to generate the necessary amount of power at these sub-stations by an independent boiler and engine? In some localities there is no reason why a central station could not supply power to several farms. For example, let us assume that we are in a neighborhood where farms are so located that we could find one occupying a central position and four others in a radius of one mile. One central farm occupies the center of our circle, and the four others at the ends of two diameters intersecting at right angles. This assumed location of these farms is a good average. Assuming that the maximum requirement for any one farm at any time of the year is 8 horse-power, our central station would then

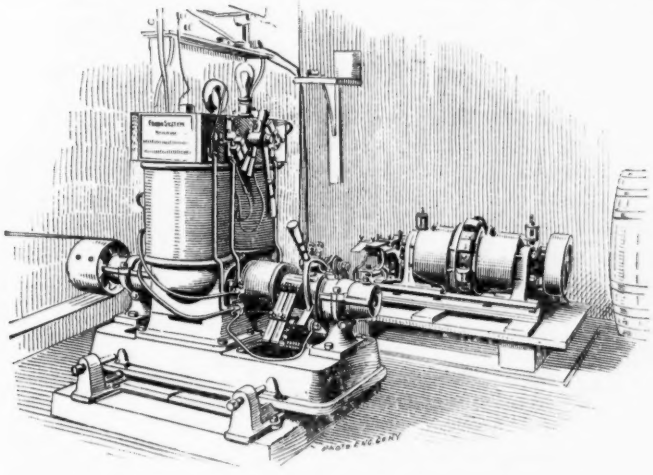


FIG. 7.—COMPOUND 12-KILOWATT GENERATOR AND ARC DYNAMO.

need for the use of the five farms, say a 40-horse-power boiler, a 40-horse-power engine, and a 40-horse-power generator. Work will be arranged on these farms so that every Saturday or every other Saturday to suit the season will be "power-day," or oftener when the year's cotton crop must be ginned or the grain crop threshed.

We will use the standard voltage now in vogue (500 volts) for transmission of power by electricity. The 8-horse-power motor at each farm will cost about $350 at the factory. Two miles of insulated wire (one mile for the outgoing and one for the return) of sufficient size to carry the maximum current with a loss of 10 per

cent. will cost about $175. Say the freight and poles will swell the first cost of the plant for each farm to a total of $625. This amount would hardly pay for an 8-horse-power boiler, an 8-horse power engine, the pump, the settings of boiler and engine, a well, smoke-stack, and the erection of a building. In our electric-motor system this building is unnecessary, for we could place our motor in the same building in which we have located our different machines.

For the central station a 40-horse-power boiler will cost $500, a 40-horse-power engine the same, and the generator about $650, or say the whole plant, set up ready to start, would cost $1800. This, divided out among the five farms, would swell up the first cost of the farm plants to $940. We would have to make our central station farmer pay the cost of erection of the station building, for he has no line to pay for. With a system so arranged power could be delivered to these different farms on certain days agreed on beforehand.

At one time we might see on farm No. 1 the winter's supply of wood being sawed; at No. 2 cotton ginned and pressed; at No. 3 the sorghum-cane crushed or cider pressed; at No. 4 a planer or a lathe at work; and at No. 5 a feed-cutter and corn-sheller, or perhaps the ensilage-cutter. With this system the farmer could saw up his own wood, gin and press his own cotton, grind up his feed-stuff and sorghum-cane, and cut up his ensilage, etc. A corn- or flour-mill could be added, and his toll for grinding saved.

Look at the advantages. The first cost of the electric system is about $250, or $300 more than the private steam-plant. The interest on this amounts to, say, $25 per year. He saves four-fifths of the wages of a fireman and (assuming wear and tear to be the same on all engines) four-fifths of the wear and tear; he saves in the hauling of fuel, he saves water, he gets rid of the element of danger from fires. Too much stress cannot be laid on this last point. If there should be a water-fall in the community, by means of a turbine we could use this natural kinetic energy and save fuel, wear and tear on boiler and engine, and other repairs. If this should be the case, there would be no comparison between the two systems as to economy.

If this motor system were in vogue, see how rainy days could be utilized. Corn could be ground up into feed-stuff for cattle or into meal for bread, cotton-seed crushed, grain threshed, cotton ginned, wood sawed into lumber, and in a variety of ways could something useful be done that requires power for its operation.

How many pretty country homes are allowed to go into ruins for the lack of a board here or a plank there. The fences could be repaired but for the lack of boards. With a saw and planer run from this electric system there would be no excuse for such neglect. The spare hours on our rainy days could be devoted to getting ready boards and planks for repairing.

Such a system would bring the people into close communion with the wonderful power of electricity, now clothed by a veil of mystery. Look at the social side. It would cause neighboring farms to work into each other's hands, all pulling together like a

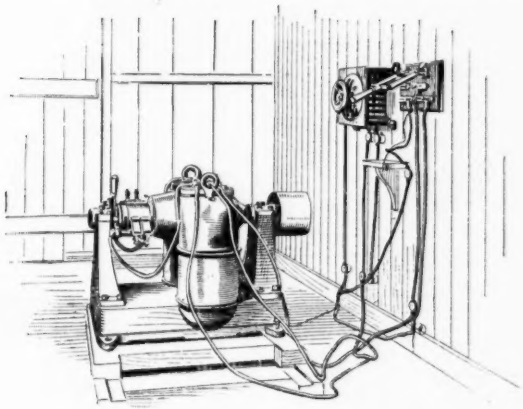
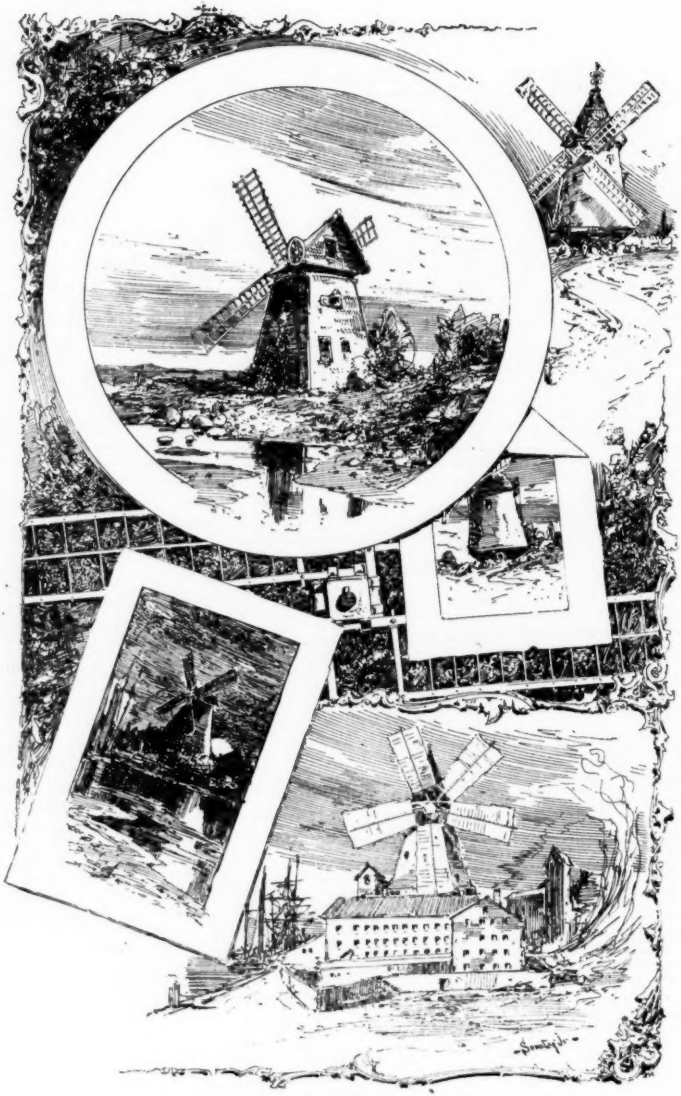


FIG. 8.—TEN HORSE-POWER MOTOR.

team of horses. It would bring them into closer intercourse with each other. If this motor system could be established throughout the country, there would be a wonderful improvement in farms and farm products. There would be more system about our farms. There would be no need of waiting for the thresher, the cotton-gin, or the sorghum-mill to come round each year. We could do their work at home. Look at the saving of our horses and mules. There is nothing harder on them than going round and round, pulling a gin or turning a screw-press. We see from our comparison above that, with the combination of five farms, there are many advantages in the adoption of this electric-motor system. With more farms in the combination of course there would be less first cost and less running cost for each farm.



SOME FOREIGN TYPES OF WINDMILLS.

[In the circle is a corn-grinding mill at Cornwall; the lower right-hand machine runs a woolen-mill near Manchester; the others are Dutch types. The designs in the center show the construction of the old-time hubs and arms.]

MODERN USES OF THE WINDMILL.

By Robert H. Thurston,

Director of Sibley College, Cornell University.

THE windmill, prosaic as it seems, ugly as it unquestionably often appears in the landscape, nevertheless calls up much of romance and interesting and impressive history, and the true artist finds place for it in many a rustic scene. The windmill has helped to make a nation, has aided in the construction of the foundations of prosperity of more than one great country, and has lent picturesqueness to many a landscape which has a more serious interest for the historian and the statesman than for the artist. The "rise of the Dutch Republic" was due to it, and the wonderful wealth and prosperity of that remarkable people came hardly less through the operation of windmills than through the exertion of their talent for commerce and manufactures. In the days of Cæsar, "within a half-submerged territory, a race of wretched ichthyophagi dwelt upon terpen or mounds which they had raised, like the beavers, above the almost fluid soil. Here, at a later day, the same race chained the tyrant Ocean and his mighty streams into subserviency, forcing them to fertilize, to render commodious, to cover with a beneficent network of veins and arteries, and to bind by watery highways with the furthest ends of the world, a country disinherited by nature of its rights. A region, outcast of ocean and earth, wrested, at last, from both domains, their richest treasures. A race, engaged for generations in stubborn conflict with the angry elements, was unconsciously educating itself for its great struggle with the still more savage despotism of man. . . . . Thus, fifteen ages have passed away and, in the place of a horde of savages, living among swamps and thickets, swarm three millions of people, the most industrious, the most prosperous, perhaps the most intelligent under the sun. Their cattle, grazing on the bottom of the sea, are the finest in Europe; their agricultural products are of more exchangeable value than if nature had made their land to overflow with wine and oil. Their navigators are the boldest, their mercantile marine the most powerful, their merchants the most enterprising in the world."

This was the Holland of the middle ages, comprised within an

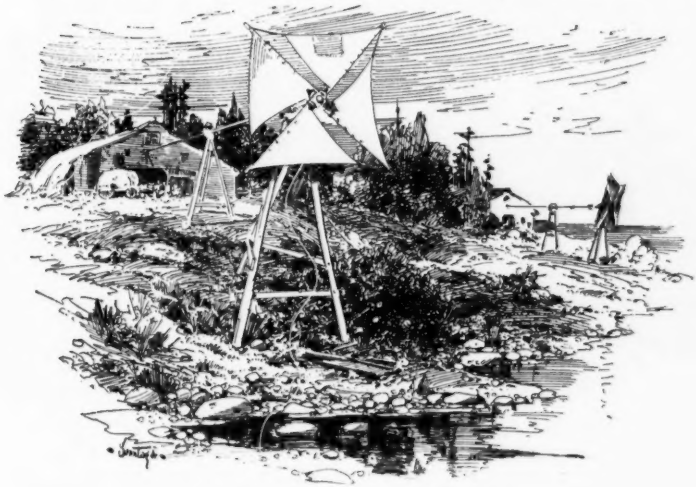
GROUP OF MILLS AT YARMOUTHPORT, MASS.

area of millions of acres captured from the fields of ocean and preserved against the assaults of the sea,—by windmills. The introduction of the power of the "mist-giant," after Watt, relieved these old guardians of much of their work; but it was in the days of windmills that the Dutch Republic, whose story is so entrancingly told by Motley, arose with its wonderful people, to traffic with the world. "Their national industry was untiring, their prosperity unexampled, their love of liberty indomitable, and their pugnacity proverbial." Without the windmill, there would have been neither country nor people to set such example to the rising nations. During the last fifty years or more this wonderful race has continued its "impoldering," and has ravished from the ocean nearly a thousand square miles of territory per year, and it has held it, largely by the aid of windmills.

Throughout Europe the windmill is still in extensive use, especially in the low countries adjacent to the mouth of the Rhine, where the writer once counted, from a car-window, as the train swept rapidly across the fens, seventeen in sight at one time. In the United States, also, these inexpensive "prime motors" are used in immense numbers, especially for raising water and the minor tasks of the country districts. Mr. Alfred R. Wolff, in his excellent treatise on this subject, published several years ago, gave the

number which had then been manufactured in a single city as above 5000, and stated that there were hundreds of thousands in operation in this country, doing many kinds of work that may, without serious loss, be performed intermittently, such as pumping and storing water, and grinding grain on a small scale in rural districts.

It is not known when the windmill was first invented. It is claimed by some early writers that it was known to the ancients, but it certainly was not mentioned in the famous work of Hero, in which the first steam-engine is described as made two thousand years ago,—the prototype of the modern steam-turbine,—and in which is illustrated the steam-fountain, the progenitor of all the steam-engines, so-called, up to the time of Newcomen. Beckmann points to the fact that windmills were not mentioned by such observing and minute chroniclers as Vitruvius, Seneca, and Chrysostom. They were in use in Northern Europe at the very commencement of the middle ages, and probably some time before. The first of the Dutch mills seem to have been mounted on floats, so that they might be turned to the wind and adjusted as required. Later, and especially in Germany, mills were mounted upon posts,

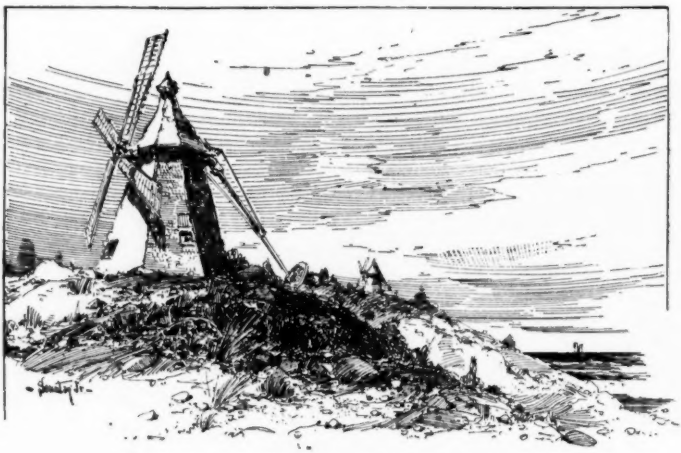


CANADIAN MILL USED FOR THRESHING GRAIN.

[This mill is on the St. Lawrence River between Pt. Levi and Riviere du Loup. Wheels and sails can be turned in any direction to suit the wind. Power is transmitted along the shaft (the direction of which is stationary) by means of a universal joint.]

upon which they could swivel ; and still later Dutch mills were built like those employed by our own fathers and grandfathers in America, with a movable top, which could be turned toward and away from the wind, as desired, carrying the sails and shaft with it, turning about its central spindle, through which the motion of the machinery of transmission was carried down into the mill below.

It is this Dutch form of modern mill that has been a favorite detail in the landscapes of the artist, painting on the banks of the Zuyder-zee or on the shores of Long Island. It is this mill which with every one whose home or whose summer resting-place has been among the hills or on the shores of New England has impressed itself upon the retina of eye and of imagination as one of the most

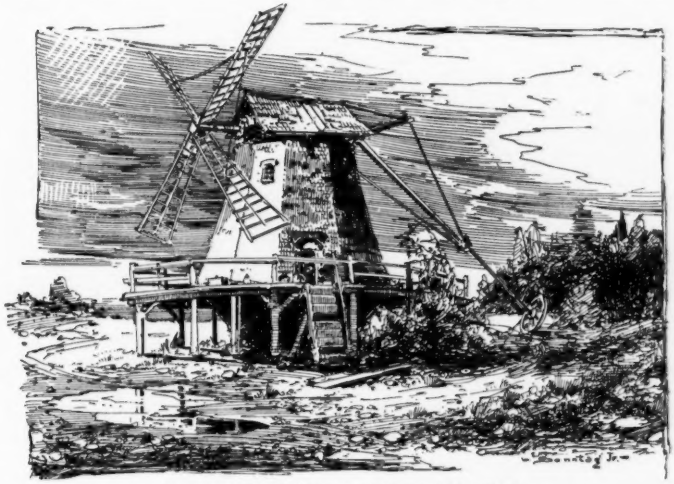


ONE OF NUMEROUS MILLS AT BREWSTER, MASS.

picturesque objects of the familiar landscape ; the swish and whirr of sails and rumble of stones constituting the most awe-inspiring sensations to him as a child, and the most pleasing of impressions when adult. The old mill at whose whirling sails his horse started in afright, at every visit to its neighborhood, at whose spout he has so often felt the flow of the meal, warm from the revolving granite stones, and at whose door he has so often talked with the quaint but intelligent character presiding over its operations,—an authority on local as on national politics, village gossip, and the news of the day,—was always a "Dutch mill."

The construction of these mills, from an engineer's point of

view, is simplicity itself. A heavy wooden shaft or axle is set horizontally, or nearly so, across the framing of the swivelling top of the mill, in journals or bearings in which it can turn, if well greased, with but little friction. On the outer extremity of this shaft are secured four wooden arms, perhaps thirty or even forty feet in length, at the four quadrants of a circle. Each arm carries a light wooden frame, of small bars set at right-angles to the arm, and connected at their extremities by rods parallel to it. On this frame the sail is stretched when the mill is in operation, or is furled at other times. The cross-bars and sails extend, usually, from the tip of the arm to within about one-sixth of its length from the cen-



OLD GRIST MILL IN A MARSH, NEAR WAREHAM, MASS.

ter of the shaft. The breadth of the sail is about one-sixth the length of the arm. Within the revolvable top of the mill a set of bevel-gears is placed, one upon the shaft, engaging with another fixed upon a vertical shaft rising through the center of the building below, and about which the top turns when adjusted to the direction of the wind. It is on this vertical shaft that the mill-stones are fixed, or to which they are geared. The regulation of the mill, with varying work or variable wind, was effected, sometimes by a brake on the turning shaft, but oftener by some system of reefing or spreading sail to just the extent desired. This was done by hand in most of the old mills, both of Holland and of New Eng-

land. In some cases, however, it was performed automatically by ingenious arrangements of weights and counterbalances, or by centrifugal-governors, like the governor of the steam-engine in principle. The sails were held up to the wind by adjusting the position of the cap or dome of the structure, carrying the shaft with it, or by auxiliary sails fixed on a "tail-piece," and arranged to turn the cap in such manner as to throw themselves out of action while bringing the cap into position, facing the wind. Illustrations of this system are seen in nearly all recent "American" mills.

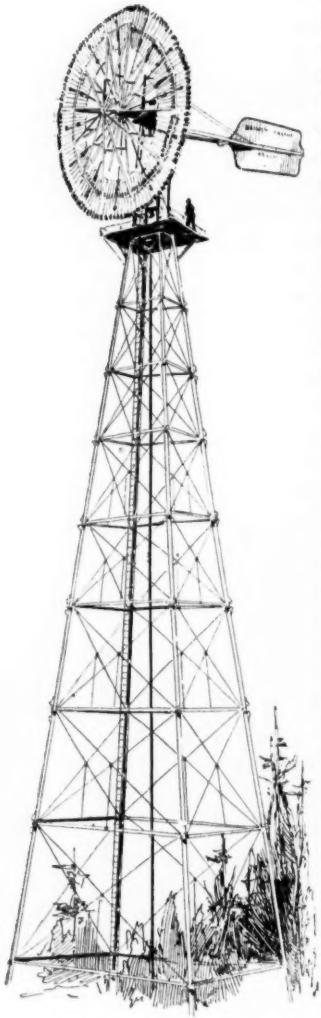
"American windmills," like almost every other product of

CORN-MILL NEAR COHASSET, MASS.

American ingenuity and skill, constitute a type, quite different from the older forms original in Europe and the East. The latter all belong to the same species, consisting usually of four arms set at angles of 90 degrees, with sails covering but a small fraction of the circle described in their revolution. The American mills consist of numerous radial arms, and have sails set so closely together that, practically, the whole circle is covered. These sails are commonly wooden slats or blades, tapering from end to end, and so set that they may intercept the whole current of air passing inside the outer circle described by their tips. They are so inclined as to deflect the air, as it passes among them, and absorb a considerable portion of its energy. Thus is formed a "screw," somewhat resembling that of a steam-vessel, but having a much larger number of blades. It is capable of giving vastly more power, and has a much higher efficiency than the old mill; though for a stated power much smaller and lighter, and more "business-like" in appearance. Naturally this improved construction, for which credit is due to the American mechanic, is displacing its older rival, even in the home of the latter, and the "American" mill is now to be seen all over the world,—England, Germany, France, Holland, and their colonies on the opposite side of the globe, having all taken it up, as they have so many other of the fruits of the genius of the "Yankee" inventor, and with results most satisfactory to themselves no less than to the inventor.

There are, according to Mr. Wolff, two principal modern types in successful use, with a number of less well-known variations upon the standard constructions. These two classes are the "side-vane" and the centrifugal-governor mills. The first has its vanes set permanently at their best angle for the best states of the weather; while their position relatively to the thread of the current is determined by a "side-vane" which receives the pressure of the wind in such manner as to throw the whole wheel around and away from the wind, if that should become too strong. In the other form, the blades are pivoted on axes running lengthwise, and are turned, as their speed varies, by a governor, in such manner as to have, at every instant, just that inclination to the wind which will give the desired speed of rotation. In moderate winds they are held at an angle of 60 to 80 degrees with the wind; in very high winds they fall almost into the line of its motion. Of these one is a simple and peculiarly durable machine; the other excels somewhat in excellence of regulation, though costing more for

wear and tear. Many varieties of American mill are now made by builders in the United States and in Europe; and there are few classes of machinery which illustrate more remarkably the ingenuity and practical genius of our countrymen. As compared with the steam-engine and other heat-motors, the power of the windmill is small and its volume large, but it is the most economical of all known motors for many locations, and, in the aggregate, it is doing an enormous amount of work for the world, and is destined to do vastly more, we may be sure, in the future.



MILL AT HOUGHTON, MICHIGAN.

[Height 100 feet; used for the village water-supply.]

The power of the best American mills varies, the wind blowing at an average of sixteen miles an hour, from about $\frac{1}{8}$ horse-power, for the mill ten feet in diameter, up to $\frac{1}{2}$ horse-power for a "seventeen-foot" wheel, and to 1 horse-power for twenty-two feet of diameter. Mills are made as high as forty feet in diameter and of 4 horse-power and even greater in special cases; but the "twenty-five-foot" mill may perhaps be taken as representative of a usual maximum, and its power, measured in useful work in pumping, is not quite $1\frac{1}{2}$ horse-power. It would require a wheel seventy or eighty feet in diameter to give 10 horse-power in a wind blowing twenty miles an hour. Twenty gallons of water raised one hundred feet in one minute is very nearly the measure of a horse-power.

MILL FOR DRIVING ALL KINDS OF FARM-MACHINERY.

[Property of Mr. J. H. Vanduzer, Thomasville, Georgia.]

The economy of this motor, as Mr. Wolff was probably the first to point out, is even greater than had been commonly realized. Its cost decreases rapidly with increase in power, from about six cents per horse-power per hour, for the "ten-foot" wheel, to about five cents for eighteen feet in diameter, and to less than three cents, under average representative conditions, for wheels of the largest sizes. In these estimates of cost Mr. Wolff, for the first time, correctly distributes the expenses of operation and the charges, including, as one item, interest on first cost; the fact having been generally overlooked that it is this quantity and not the first cost itself which measures the tax on the purchaser and user. The best mills cost from about $600 for the ten-foot wheel of ⅛ horse-power to $1200 for the 25-foot wheel of 1½ horse-power or less. In the estimates a working-day of eight hours is assumed; but the machine, when used for pumping, its most common application, may actually do its work twenty-four hours a day for days, weeks, and even months together, whenever the wind is "stiff" enough to turn it. It costs, for work done in situations in which its irregularity of action is no objection, only one-half or one-third as much as steam-, hot-air-, and gas-engines of similar power.

The small cost of this power, and the fact that nature provides the original store of energy throughout the world, free to all, make the windmill widely applicable for the various uses of man. At Faversham, it is said, a 15-horse-power-mill raises 2,000,000 gallons a month from a depth of 100 feet, saving ten tons of coal a month which would otherwise be expended in doing the work by steam. In Holland large numbers of mills are holding back the floods from the "polders" and grinding "trass"; they are seen in every gentleman's garden, raising water for irrigation and for domestic uses; they besprinkle alike the marshes and "meers" of northern Germany and the prairies of North America, the "steppes" of Tartary and Siberia, and the wide interior plains of Australia. They constitute one of the three great tribes of genii ministering to the wants of man by turning every energy of nature into prescribed paths and subduing it to the purposes of the race. Steam, water, and air, each storing its own peculiar form of energy of motion, do the work of humanity.

A promising and perhaps rapidly-approaching development of wind power is that proposed by Sir William Thomson years ago,—its employment to store electric energy in "storage-batteries," intermittently working with the variable winds, laying in a stock of energy

MILL FOR RAISING WATER.

Property of Mr. R. G. Dun. "Dunmere," Narragansett Pier, R. I.

to be afterward regularly and steadily given out in supplying lights and power, and possibly heat as well,—in short, for all the thousand-and-one new purposes to which electricity is constantly finding application. For such work the fitfulness of the winds is a matter of little importance, and their variable efforts, employed night and day, yield, later, a large and inexpensive store of power for transformation, or for transmission without transformation, as may be found desirable, and which may find use in every operation of the home and farm, or of the small industries of the cities.

The magnitude of the store of aerial energy upon which mankind may draw, so long as the race exists upon this earth, is beyond the reach of the imagination to conceive, but not beyond the power of computation of the mathematician. Taking the quantities roughly and in "round numbers," the atmosphere weighs about a ton to every square foot of the earth's surface; 25,000,000 tons per square mile, or 5,000,000,000,000,000 tons on the total of 200,000,000 square miles. Its energy is that due to the motion of this inconceivable mass, at velocities varying all the way from the gentlest zephyr to the hurricane and the cyclone, rushing over the prairie or along the surface of the sea at more than a hundred miles an hour. A cubic mile of air weighs about 10,000,000,000 pounds, and, at the rate of motion of the cyclone, develops 4,000,000,000,000 "foot-tons" of energy, and, if all employed at this rate for the performance of work, useful or destructive, this 8,000,000,000,000,000 "foot-pounds" would be equivalent to more than 2,000,000,000,000,000 horse-power. If the disturbance reaches the exterior of the atmospheric shell, inclosing the earth, it embodies 10,000,000,000,000,000 horse-power, or millions of times as much as the highest estimates make the probable whole steam-power of the world at the end of the nineteenth century.

Assuming the moderate velocity of 16.7 miles an hour for the whole atmosphere of the globe, its energy per mile is one-thirty-sixth of that just computed, and 5,000,000,000,000,000 tons of atmosphere would represent about 50,000,000,000,000,000 foot-tons of energy and not far from 50,000,000,000,000 horse-power; certainly more than a half-million times as much power as have all the engines in the world combined. Each cubic mile would store 40,000,000,000 horse-power; and every square mile, could 100 feet of its superincumbent atmosphere be utilized, would yield about 80,000,000 horse-power, which is not far from the aggregate of the existing steam-power of the world.

FIRE LOSSES IN FIRE-PROOF BUILDINGS.

By Charles H. Bebb.

THE advancement in the science of building construction during the past ten years has developed the necessity of a radical revision of accepted ideas in building, especially in our larger cities. Some of the factors in bringing about this revision have been the introduction of the "sky-scraper" of skeleton-construction system, with the network of steel and iron; the need of practically, scientifically, and absolutely covering the "skeleton" inside and out with incombustible material, under widely varying conditions and contingencies; and the advance of sanitary science. The one paramount reason, however, for the widespread interest which is beginning to be felt in regard to methods of building is to be found in the enormous fire losses that have occurred throughout the country, not alone in buildings of ordinary construction, but in those which were presumed to be fire-proof.

Scarcely a week goes by that one or another of the journals devoted to architecture does not contain some article by experienced and able writers, bearing upon the fireproofing of buildings, and without doubt there could be formulated from these articles a system of principles that would be thoroughly efficient to meet the requirements. In the attempt to discover right principles the advice and assistance of the now noted fireproofing companies should not be neglected. The demand was no sooner created for a science of fireproofing than it was immediately met by the formation of companies for the very purpose of supplying it. The new industry, with experience as its teacher, has developed year by year, until at the present moment there is not a first-class architect or engineer in the country who will deny that an absolutely fire-proof building can be built, and at a reasonable cost. Yet fires of the most disastrous character are constantly occurring in buildings advertised by their owners as fire-proof. It is not surprising, therefore, that a large element—probably a vast majority—of the entire community doubt the possibility of constructing an absolutely fire-proof building. It is an incontrovertible fact that every fire which has taken place in a "fire-proof" building has been due to the indiscriminate use of combustible material in its construc-

THE BURNED CHICAGO ATHLETIC CLUB BUILDING.—I.

[Third floor, looking west. The floor immediately under the gymnasium where the fire started.]

tion; moreover, it may be demonstrated that fire-proof material could have been substituted for the material burned at a cost not exceeding 20 per cent.

Of the so-called fire-proof buildings in which fires have occurred, the Stillman apartment building, in Cleveland, may be recalled. The top story and roof were of wood, and were burned, while the lower stories, of modern fire-proof construction, remained uninjured by fire. The roof of the Chicago Opera-House, which also was of wood, was entirely destroyed, though the fire did no damage to the remainder of the building. The old section of the Lumber Exchange building, in Minneapolis, which burned, was not a fire-proof building, as we understand the expression to-day. It was a nine-story building of ordinary wooden construction, "fireproofed" by the application of tiling to the wood, and

had a two-story addition to it of modern fire-proof construction. The lower nine stories burned entirely out, while the two upper stories remained intact,—a substantial triumph of successful fireproofing. None of these buildings, therefore, could be considered perfectly fire-proof, though all them were advertised as such. The first and only record of disastrous fire in what was really intended for a perfectly fire-proof building, entailing a loss to the insurance com-

THE BURNED CHICAGO ATHLETIC CLUB BUILDING.—II.

[Fourth floor, looking into Gymnasium from ante-room on the northeast corner.]

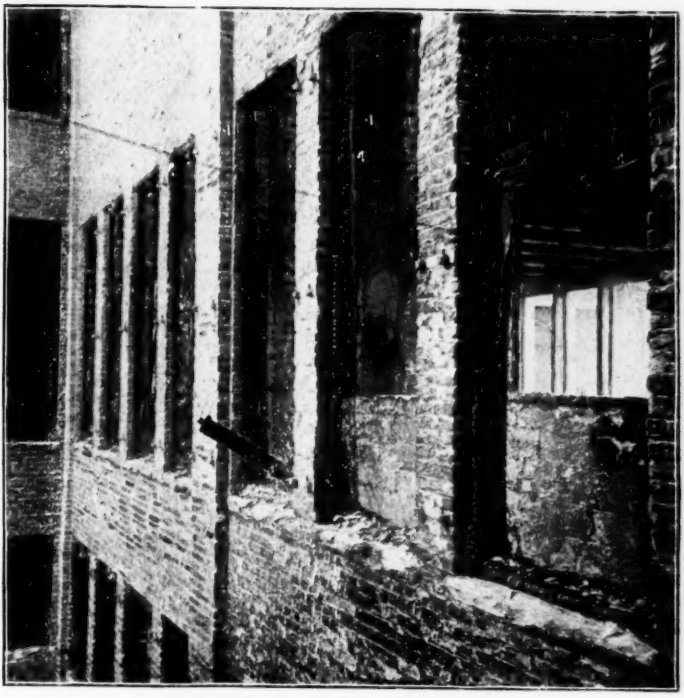
panies of more than 30 per cent. of its value, was the burning of the Chicago Athletic Club building. We have said in a building "that was really intended for a fire-proof building," and as the facts have been so widely discussed in garbled form by the general press all over the country, we shall endeavor to substantiate the statement.

THE BURNED CHICAGO ATHLETIC CLUB BUILDING.—III.

[Sixth floor, looking through windows into stair-well where the fire came up.]

The Athletic Club building, at the time of the fire, was rapidly nearing completion. On the morning of November 1, about 1.30 A. M., fire was discovered on the fourth floor, but not until it had assumed such proportions that it appeared that the building was certainly doomed. To say that the fire burned until it burned itself out sounds like a slur on the very excellent and efficient Fire Department of Chicago ; and yet a visit to the scene and an exami-

nation of each separate floor demonstrated the fact that almost every particle of combustible material, not excepting the window-frames bricked in the openings, was consumed. Such was the intensity of the heat that the surface of the fireproofing material and the exposed face of the brick in some places on the fourth and fifth floors became fused, and the molten glass from skylights in the courts on either side of the building ran down the walls like tallow-



THE BURNED CHICAGO ATHLETIC CLUB BUILDING — IV.

[Court eighth floor. Shows how fire came up from below, no fire having gone through any of the tile floors.]

grease. The Chief of the Fire Department, in one of the newspapers, was credited with saying that he never saw a hotter fire than in this very modern and fire-proof building.

The result to the building has been the complete destruction of the costly and beautiful front above the third floor, and, as before stated, the destruction of all interior finish in place and otherwise.

THE BURNED CHICAGO ATHLETIC CLUB BUILDING.—V.

[In the Drawing-Room, eighth floor, looking northwest. Partitions knocked down by water from hose. Ceiling uninjured.]

of both wood and plaster. It goes without saying that all iron piping and electric wires suffered the same fate. Here, however, the damage ceased. In its structural entirety the Athletic Club building remained apparently intact. The tile arches of porous terra-cotta, set according to the very latest adoption in construction,—namely, the "end construction,"—are practically uninjured by the combined action of intense heat and tons of cold water; not one arch has fallen, and recent tests made on the worst looking arches developed a sustaining capacity of 450 pounds per square foot, without sign of rupture. The partitions, also of the same material, were practically intact, and as originally built, except that every door, door-frame, and casing, and all base, wainscoting, and wood work of all descriptions entirely disappeared, and the plastering was completely stripped off, leaving the tile bare. The wood floors were entirely consumed, and in many places the strips bedded in the concrete to receive the floor were burned completely through.

In regard to the column protection in itself, to be considered of paramount importance in the fireproofing of a building, a piece of unmitigated folly almost inconceivable in its carelessness has been exposed.

Before stating the method that was adopted, a few general remarks on the slighting manner in which this work is usually done may not be out of place. The function of a column is to support a load, and the higher the building the greater the load; the greater the load, the more necessity for care in fireproofing. Of the general public who by thousands and thousands pass in and out of our modern tall office buildings, how often does one pause to think, as he passes an isolated column in the lower stories, that it is probably carrying from 150 to 175 tons? Not one in ten thousand; and the architect who designed the building, from the manner in which the protection is often applied, apparently thinks as little. The dimensions of the iron itself, whether of cast iron or steel, are very properly reduced to their safe carrying load. The shape having been determined, the dimensions are worked out by well-defined formulæ and accepted. But from this point dimensions of the column become a bugaboo to owner and architect. Almost any scheme that will keep the size down to a minimum is adopted. Miles of vertical piping for soil, waste, supply, and revent enter into the construction of modern buildings of large size. And they run from basement to attic alongside of the most con-

THE BURNED CHICAGO ATHLETIC CLUB BUILDING.—VI.

[Dining-Room, looking west. Tile ceiling uninjured.]

venient column. Consider for a moment the space required for the pipes for a stack of wash basins in an office building. We have waste, hot- and cold-water supply, safe waste, and re-vent, running vertically against the nearest column. A plumber's helper, with hammer and chisel, is sent to cut away the tile arch at the base of said column at each floor. The hole is made "large enough" to permit the passing through and screwing up of pipes with little difficulty to the plumber. All building nowadays is a "rush job," and there is no time to fill in and patch these holes with concrete, and even if done, the chances are that the plumber will begin turning again on one or other of the pipes before the concrete has become set, and in consequence it falls out. The piping completed, the fireproofer starts to get in his work. The finished plaster line from which the tile is to be kept back three-quarters of an inch is generally his guide and is rarely more than two inches from the extreme edges of the iron column. Then is the ingenuity of the mason called forth, and it takes a mechanic of no mean skill to accomplish the work within the requirements. With one-inch slabs and plenty of mortar to make them "stick," he makes a fair job on two sides of the column; then grooves are cut in the tiles, often reducing the material one-fourth in order to cover a pipe that projects "a little too far"; if however the mason is "rushed," he does as well as he can with chips and mortar, plasters the exposed pipe with mortar, and with a few nails and some cheap flexible wire a double fact is accomplished. The column is "fireproofed" ready for the plasterer, and a continuous flue, 150 feet high perhaps, for the possible passage of heat and flame, is created, with the bare surface of the iron column as one side of said flue. This may seem an exaggerated statement, but it is a fact, nevertheless, and can be demonstrated in almost any "fire-proof" building. This, of course, is bad, as by the sacrifice of some space the fireproofing of the column could be properly done and an enclosed shaft for pipes built alongside. Where, however, there are no pipes, there is no excuse at this late day for not putting on an efficient covering. The casing of the columns in the Athletic building — we refer especially to isolated columns, *i. e.*, without pipes alongside—in no case exceeded two inches from the utmost edge of iron.

Starting from the floor, between floor and ceiling, about every 3′ 0″, a piece of 2″ by 4″ scantling was bedded on the tile and against the column, the 4″ of wood being left exposed, so that "fire-

proofing" of the columns was accomplished by successive courses of 3′ 0″ of tile and 4″ of wood. In the gymnasium proper, a story about twenty-five feet high, these strips of wood formed the "grounds" for the paneled oak wainscoting extending from floor to ceiling. The oak was applied directly to the grounds, no back-plastering being used, so that the irregularity of the tile allowed an excellent passage for flame and air. The corridors throughout had oak wainscoting five feet high; the floors generally were two thicknesses of wood, a 6″ x 1″ fencing, and a 1″ maple floor nailed to it. Wood strips at sixteen inch centers received the fencing. The doors appear to have been $1\frac{3}{4}$″ veneered oak, rough stud frames, with finished oak frame inside and fairly wide casings. The ceiling of the gymnasium (the high story) was of paneled oak over the entire area, to receive which 1″ strips had been nailed to the tile arched in such manner that there was plenty of space for flame and

THE BURNED CHICAGO ATHLETIC CLUB BUILDING.—VII.

[Barber-Shop on first floor, water-soaked.]

air current. The back of all wainscoting and oak panel-work on ceilings would doubtless have received a "heavy coat of lead and oil" before being applied. The racing track, which formed a mezzanine floor in the gymnasium, had rounded ends, the outer curbs of which were formed by wooden supports spaced close together; the exact construction was no longer traceable, the fire having left a mere ash heap at each end.

In the October (1892) number of THE ENGINEERING MAGAZINE Mr. John M. Carrère has given the public a very able paper on "Interior Fire-proof Construction," and he refers to Mr. Edward Atkinson's paper on "Fire Risks in Tall Office Buildings" in the May number of the same Magazine. To this paper we also wish to refer in so far as it may bear on the recent fire under discussion. Mr. Atkinson writes (on page 152):

> In very many other very solid buildings, of which the main elements are well devised and which ought not to be exposed to any considerable hazard from the combustion of any part of the building itself, every consideration of fire appears to have left the mind of the owner, builder, and architect when dealing with the finish of the building. I can designate well-constructed brick and iron buildings in which the iron beams and posts are sometimes well protected from the direct exposure to heat but are more often exposed, but which have been finished for occupation:
>
> First, by the construction of combustible wooden dados on the walls, which are wholly out of place.
>
> Second, by sheathing the walls with very combustible fine wood fastened solidly against the brick work.
>
> Third, by heavy combustible wooden moldings or frames around the doorways in which wooden doors are placed.
>
> . . . . Lastly, the building being thus supplied with light wood in sufficient measure to tear any building to pieces by expansion when the wood is fully ignited, this wood-work is finished with the most combustible turpentine varnishes, over which a fire runs with the speed of a race horse, assuring its rapid ignition.
>
> I once computed the heat-units in the many cords of pine wood partition, sheathing, etc., in what purported to be a slow burning warehouse of heavy mill construction, and I found that it would have sufficed to supply charcoal enough to melt a large charge of pig iron in a puddling furnace.

The Athletic Club, had it been built when Mr. Atkinson's article was written, might have served as an example of the worst features he condemns. Having used steel beams and tile fireproofing as the main elements of construction, further consideration of fire hazards were apparently unnecessary.

The result of the wooden grounds around the columns of course obviated to a great extent the use of fireproofing, for as soon as the fire reached them, they burned out and the tiles dropped. That

the building did not collapse, considering the intensity of the heat, the duration of the fire, and the load on the columns at the floor, where was the greatest heat and where the columns were longest, is one of the inexplicable cases of Providence. The columns were of steel of Z-bar construction. To what degree of heat they actually attained will always be a matter of speculation; also whether they were allowed to cool slowly or were subjected to sudden cooling by streams of cold water will never be known. No experiment within the bounds of economy can safely be made upon them to discover the present nature of the steel. Neither can the amount of expansion and contraction which has taken place be determined with accuracy. Therefore we may presume that, left in its present condition without structural reinforcement, the stability of the building is an unknown quantity.

The result of this great fire demonstrates two great facts. The first is that laws governing the fireproofing of high buildings do not begin to be efficient, and will not be until the possibility—to owner and architect alike—of using unnecessary combustible material is absolutely precluded, the term "unnecessary" being practically and specifically defined. The other fact is the superiority of the material used for fireproofing in this particular building. This matter deserves very careful consideration, for we have two elements diametrically opposed which cannot be considered apart in any fire, great or small. What we require is the material that will best resist the combined action of *fire* and *water*. The first actual data upon this subject fortunately was given in a widely-read architectural periodical.* The paper referred to gave a detailed account of comparative tests of different fire-proof materials made at Denver, Colorado, at the time the award was made for fireproofing the Equitable building in that city. The result demonstrated the unqualified superiority of porous terra-cotta. While the results obtained then may have been regarded as still problematical, this recent fire has been a practical test of their accuracy beyond question.

In conclusion, while we agree with Mr. Carrère in his statement that the insurance companies have it in their power to bring about the radical and required revision of principles of construction, we do not think that the entire onus should devolve upon them. There is an American Institute of Architects, an association possessing in its members talent of the highest order. The object

* *American Architect and Building News*, March 28, 1891.

of this association is not money, but "combined effort for the promotion of the artistic, scientific, and practical efficiency of the profession." On a matter so vital and so entirely a part of the association's profession, shall no voice arise from its midst demanding a part in the discussion? Shall it remain passive and allow the all-dominant spirit of the times to be the essence of the movement? For, after all, the reason of the concerted action of insurance companies to formulate new rules is merely an effort to save, and therefore to make, dollars and cents. Or shall the Institute, from the highest motive of public good and for the promotion of science, come forward and at least concert with the insurance companies in a matter that concerns them so closely, and so declare themselves against the indiscriminate use of wood in fire-proof buildings that the public will be assured of the fact that a building erected by any of the members and pronounced by them to be fire-proof is so? Under such a declaration, no coercion on the owner's part, no false consideration of economy, no false taste, will permit them to follow a course which they know to be wrong from an esthetic, scientific, and practical standpoint.

MEXICO AS AN IRON-PRODUCING COUNTRY.

By Robert T. Hill, M. Am. Inst. M. E.

UNTIL within the past decade Mexico has had but small share in the benefits of the age of iron, and even now that material is but little used in her homes and other structures. Heavy transportation from the interior is still carried on mostly by carts having no iron in their construction; the wooden plow still cultivates the soil; pottery supplies the place of iron in domestic utensils; even the windlasses and the machinery of some of the oldest and most productive mines are made of wood. The most common iron castings are sold in Mexico at prices approximating that of bar copper in the United States.

But the Spanish-Arabian industrial customs that have prevailed since the conquest are changing, and the consumption of iron has increased so much during the last ten years that Mexico may now be considered a most profitable market for the iron-workers of other nations. Within this time her formerly unstable government has been strengthened by the construction of more than 6000 miles of railways and 30,000 miles of telegraph lines. During the same period the iron imports have increased from a value of $1,500,000 in 1871 to $17,000,000 in 1891–92.

Before the construction of these railways many States were practically inaccessible to the explorer and only the precious metals were considered worthy of investment, but now more ordinary natural products are receiving attention and among others the large deposits of iron ore. As will be shown in this paper, these ores are of an extent and quality that make it impossible for Mexico to remain longer a mere consumer for other nations, but will place her among the iron-producing countries. The 13th of November, 1892, witnessed an event which marks the first step towards this end. On that day the officers of the Mexican International railway and the State and the Federal authorities celebrated the completion of a railway to the foot of the Sierra Mercado, or iron mountain of Durango. For several years this line had progressed southwestward from Eagle Pass, Texas, through a country for a large part barren and desert. When Mr. Collis P. Huntington witnessed the final ceremonies at Durango, the wisdom of his in-

vestment became evident, for it was seen that the road at one end owned the coal-beds of Coahuila and at the other this celebrated mountain of iron ore.

The iron mountain of Durango has long ranked among the wonders of Spanish North America. Early travelers surrounded it with descriptions as fascinating as those told of the seven cities of Cibola. Even Humboldt recorded it as an immense mountain of meteoric iron, while Weidner, some fifty years ago, asserted that it was a vast outburst of molten iron, of volcanic origin, having connection with a still greater subterranean supply. Reclus asserted that the mass of iron contained above ground enough metal to supply the whole of North America for a hundred years. Thanks to Mr. John Birkinbine,* president of the American Institute of Mining Engineers, and Professor Benjamin Silliman, the mineralogist, the true nature and extent of the mass have been described.† The former, after a visit in 1882, described the mountain as follows :

> Just beyond the limits of the city of Durango, and less than two miles from its center, rises the Cerro de Mercado, a hill nearly a mile long and a third of a mile wide and from 400 to 600 feet in height. The surface of the mountain exposing ore, classified as good mining lands, aggregates ten million square feet, but there are indications that the deposits are not all above ground. I incline to the belief that the Cerro de Mercado is formed of one or more lenses of specular ore, standing nearly vertical, the fragments of which have for ages been thrown down to form the slopes of the mountain as a talus. I am free to say that, after having visited the iron ore mines of the United States, I have as yet found nothing to compare as to quantity in sight with the Cerro de Mercado of Durango.

The ore, as shown by Professor Silliman, is specular hematite, accompanied by the peculiar form of hematite known as martite, a pseudomorph after magnetite, for which it is often mistaken. In composition, the pure ore contains 62 per cent. of metallic iron, while average specimens selected to show the run of the whole mass yield 52 per cent. of iron.

The fortunate possessors of this mountain and the enterprising constructors of the railway to it cannot be congratulated, as yet, upon the control of all the iron deposits of Mexico, for there are many other localities in that republic where similar ores are found

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* "The Cerro de Mercado of Durango," by John Birkinbine. [Transactions of the American Institute of Mining Engineers, 1884.]

† "Martite of the Cerro de Mercado, or Iron Mountain of Durango, and certain other Ores of Durango," by Prof. B. Silliman. [*American Journal of Science*, November, 1882.]

in quantities sufficient for the establishment of great iron industries, which will add ultimately to the prosperity of the country. Several deposits have been studied recently by the writer of this article, and one of them will be described in order that the geological occurrence and availability of the ores in general may be understood. This iron locality is near the city of Monclova, on the line of the Mexican International railway, and some 300 miles nearer the coal supply. The mountain in which the ore occurs, like that of Durango, is called the Sierra de Mercado. It is one of the elongated mountain masses characteristic of the Great Basin, or arid region of the United States, of which the so-called Mexican plateau is a geographic continuation, and is surrounded by the customary basin plains composed of the filled-in debris of the surrounding mountains. The structure of the mountain is of subvertical strata of hard blue limestone, resembling the Paleozoic limestones of our own Appalachian region, but is of much later geological age, belonging to the Lower Cretaceous period. Through this limestone has been thrust vast masses of eruptive diorite. The base of the mountain is embedded in a talus or conglomerate, largely composed of limestone debris, but accompanied by innumerable rounded lumps of iron ore, resembling that of Durango, and occurring in such quantity as to suggest that this detrital material alone would be valuable for the iron-maker.

Upon ascending the mountain to a height of about 1000 feet above the railway track, the original source of the ore is found in several enormous outcrops, occurring in line in a direction north and south, along the parting between the limestone and the diorite. It is hardly necessary here to give the details of each of these bodies, which have been described in a more technical paper,* but it is sufficient to say that more than 17,000,000 tons of ore were exposed at the surface. This ore is of the same general character as that of the Durango beds, consisting of rich specular hematite and martite. One of the outcrops has been studied by Dr. Persifor Frazer, of Philadelphia, and the results published in the "Transactions of the American Institute of Mining Engineers." He speaks in the highest terms of its quality and quantity. "In order to test the value of this ore severely," he says, he took "a sample across the face of the vein inclosed in the pit, inclusive of a 'horse' of limestone there visible, and some scattered masses of

* "On the Hematite and Martite Iron Ores of Mexico," by Robert T. Hill. [*American Journal of Science*, February, 1893.]

sandy material which gave 53.80 per cent. of metallic iron," upon analysis. Sixty specimens, collected with a view of showing the average by another gentleman, gave 64.83 per cent. of iron.

The geological conditions surrounding the iron deposits of Monclova are typical of nearly all the Mexican region, which may be briefly described as folded sedimentary rocks of Cretaceous limestone, through which eruptive rocks protrude. Only along the southern border have the older Archæan rocks been reported by trustworthy authorities. With these principles in mind we can more readily understand other bodies of similar iron ore, which have been reported and have wide distribution as follows:

About sixty-five miles southwest of Laredo, Texas, seven miles west of the little railway station on the Mexican National railway which bears the euphonious name of Solomon's Bottle (Salome Botello), are several other large bodies of ore, similar in composition to those of Monclova and Durango. These are situated in the Sierra Carrissal, the southern mountain of the range known as the Sierra Candella. The ore masses examined by the writer are of enormous size, but they have not yet been surveyed sufficiently to permit their capacity to be stated. The country rock is the same character of diorite and limestone as that of Monclova. This ore could easily be shipped by present railway communication to Monclova, Monterey, or any other point where furnaces may be erected.

Proceeding southward, ores of the Durango type have wide occurrence in the States of the Pacific-border region. Iron has been smelted for many years in the states of Jalisco, at Tula, in Hidalgo, at Encarnacion, and in Oaxaca at Xanica, in crude Catalan furnaces. The ore bodies of this region seem in many cases large, and practically inexhaustible. The ores used at Tula have been described in the "Transactions of the American Institute of Mining Engineers," by Mr. J. P. Carson, of New York. With the exception of the Amole mine, which occurs at the contact of trap rock and sandstone, and yields only 40 per cent. of iron (the average of the Lehigh Valley ores of Pennsylvania), the other deposits are all analogous to those of Monclova and Durango. In the district of Chiquistilan the formation is limestone, and penetrated in various directions by volcanic dykes. In the Tecotes mine the "vein is what is termed segregated, occupying a space between parallel seams of limestone."

In the State of Guerero, of which Acapulco is the principal sea-

IRON IN MEXICO
BY
Robert T. Hill
Hematite Ores in Quantity.
" " of Unknown Quantity.
Good Coal.
Lignites, etc.
Railways.
Localities alleged to be Magnetite
GOLFE
DE MEXIQUE
BASSE CALIFORNIE
GOLFE DE CALIFORNIE
CHIHUAHUA
COAHUILA
DURANGO
NUEVO LEON
TAMAULIPAS
ZACATECAS
SAN LUIS POTOSI
JALISCO
MICHOACAN
GUERRERO
OAXACA
TABASCO
CHIAPAS
Eagle Pass
Monterey
Saltillo
Matamoros
Durango
Guadalajara
Morelia
Acapulco
Oaxaca
Vera Cruz
Tuxtepec

port, these masses of iron ore have unusual development. Manross, in the *American Journal of Science* (May, 1865), describes eight localities, any one of which would furnish ore for the establishment of extensive iron industries. One of these, on the river Mescale, near the village of that name, is described as a nearly vertical vein, twenty-five feet wide and composed of solid ore. Another deposit near the coast at Coyuca, is known as the Cerro Yman, or Magnet mountain. "It is a mountain of iron ore fully equal to the celebrated ore of Missouri. It is about 300 feet high, half a mile long, and fully one-third of its bulk is pure magnetic ore." He further says: "The finest deposit we have seen is near Chutla, on the road from Zacatula to Acapulco. It is not more than three miles in a direct line from the sea and not more than six from a bay that affords good anchorage and landing. This deposit extends along the side of the mountain for more than a quarter of a mile. It is several hundred feet wide, and affords masses of ore from all sizes from ledges down to pebbles. On the upper side the deposit is bounded by a thick ledge of limestone, affording an easy supply of flux. The country for many leagues around is covered by a dense forest of hardwood, which would produce an unfailing supply of charcoal." There are many references to similar deposits of iron in the reports on Mexican geology, in the States of Hidalgo, Mihoacan, Queretero, Zacetecas, and San Luis, and eight deposits are described by Ramierez on the isthmus of Tehuantepec.

Iron ores have also been reported from the northwest states of Sinaloa, Sonora, and Chihuahua, but little is known concerning their quantity. The Sinaloa localities, however, produce the same character of hematite martite ores as the mines of Durango. In fact there is reason to believe that this is the character of all the ores we have mentioned, as outlined upon the accompanying map. Iron is also reported in Vera Cruz and in lower California, but no authentic descriptions of the localities are extant. All these ores, so far as tested, are of extraordinary purity and richness.

The only ores in the United States which approach the Mexican ores in amount of iron are those of the Lake Superior and Adirondack region, the former being transported many hundred miles for reduction. Mexican ores far exceed in value the Appalachian Silurian ores of the Alabama-Pennsylvania region. This is asserted upon the authority of analysis made by our most eminent iron experts and chemists, and taken from the "Transactions of the American Institute of Mining Engineers." The injurious elements

of phosphorus and sulphur are also small, and according to Mr. McCreath, the eminent iron analyst, are less than the average of our mill and forge irons. In writing of the Monclova ores, Dr. Frazer said: "This ore, as will be seen, is remarkably pure and rich, and suitable for the manufacture of steel. It would be of great value as a mixture with cold short ores, and would pay for a long and expensive transportation. The writer cannot say positively how large an area is covered by the float ore of the La Paloma, which gave the analysis introduced into this report, but it is his belief that it will cover 7,000,000 square feet, while the total absence of phosphorus indicates that this ore is much more valuable than that which was the subject of Mr. Birkinbine's examination."

Mr. Birkinbine, the highest known authority on iron ores in this country, says of the Durango deposits: "A deposit which covers 10,000,000 square feet, and yields an average of 55.8 per cent. of metallic iron from samples containing considerable foreign matter, is unusual, and the samples from an area of nearly 7,000,000 square feet, which analyze 63 per cent. of iron, demonstrate the value of the deposit. The only constituent of the ore which shows to a possible disadvantage is the phosphorus, and by the application of the basic lining it could be used to produce Bessemer steel." Other analyses show much less phosphorus, and from some localities none at all. From the foregoing testimony of some of the best-known iron experts of the world, there can be no doubt but that Mexico possesses, in widely-distributed localities, superior beds of iron ore, in quantity to establish large industries. The accessory conditions of iron-manufacture must exist, however, before the ores can be declared available. The question of fluxes can be dismissed with the statement that hard limestone of superior quality exists coëxtensively with these ores throughout their distribution, and in most instances in direct contact with them.

Good ore and fluxes would be of little value without fuel to reduce them, and this is the greatest problem that confronts the possibility of Mexico's becoming an iron-producing nation. In general, these deposits, especially in the northern states, are situated in desert regions void of wood suitable for charcoal-making, but the southern coastal state of Guerero could not possibly secure a greater blessing than to have a forest-consuming blast-furnace attempt what no other agency has accomplished,—the destruction of a superabundant tropical arborescent growth. Coal is the iron-making fuel of the world, however, and without it Mexico could

utilize these ores only in limited quantities. In general, the geological conditions of the republic are unpropitious for the discovery of extensive coal-fields upon the scale of those developed in our own country, but within the past few years several important coal-fields have been opened, and it is probable that these are of sufficient extent to supply the future industrial needs of the republic as soon as brought into line of railway transportation. The most extensive of these is in northern Coahuila, on the line of the Mexican International railway, about sixty miles from the Monclova iron ores, and 300 from those of Durango. The same field extends to within twenty miles of the Candelia ore. This coal is of a superior quality, similar in age and character to the Cretaceous and Laramie coals of the Rocky Mountain region. The Southern Pacific railway system at present utilizes the output, but the field is so extensive that there is every reason to believe that, when the railway authorities are willing, they can supply from these mines, which they own, an abundance of cheap fuel for the iron industry. Good anthracite is also reported to be abundant upon the Yaqui river of Sonora, about 100 miles from its mouth.

According to an official report of the Bureau of the American Republics at Washington: "It is stated on good authority that plentiful coal deposits have been discovered in the district of Justlahuaca, Oaxaca. . . . . In June, 1890, there were fifty-one mines in the State of Pueblo, few of them being worked. . . . . In the same year coal was discovered in Jalisco, on the borders of Lake Chapala and in the Ameca and San Gabriel valleys. Deposits have also been discovered in the States of Tlaxcala, Vera Cruz, Hidalgo, Tamaulipas, and Nueva Leon. Some of the coal discovered in the latter States is now being burned on the locomotives of the Mexican National road." The Mexican geological map gives the occurrence of extensive coal deposits in Oaxaca and Guerrero, near the iron deposits. Even at the present price of coal in Mexico, it is possible to manufacture iron at great profit, owing to the high rate of duties on imported iron.

The conditions of transportation in Mexico have been revolutionized since the ore deposits mentioned in this paper were first described. Since the construction of more than 6000 miles of railways, none of the large ore bodies are a great distance from either railway lines or from water navigation.

The final question concerning the manufacture of iron in Mexico is, "Will it pay?" "It is difficult to believe," wrote Mr. Birkin-

bine, "that the citizens of Durango, living under the shadows of this great iron deposit, pay 25 cents per pound for nails, or 10 or 15 cents per pound for ordinary bar-iron and castings, or that rails, spikes, and bolts for the street-railways now being constructed in Durango are purchased abroad, and brought at heavy transportation charges to the foot of this mountain of rich iron ore. Yet such is the case, and no local effort has been made to work the ore, except upon a small scale."

With a population of 12,000,000 in Mexico, who should freely use this metal, it strains our credulity to believe that the high price of iron almost debars them from its use, except in most imperative needs. The prices for all grades of common iron ware are from two to ten times the amount charged in our country, as the writer has had abundant opportunity to verify by his travels in Mexico.

Notwithstanding the high price of iron in Mexico, its consumption is increasing at a remarkable rate, as shown by the following statistics compiled from the official publication of the Minister of Promotion:

IRON AND STEEL IMPORTS INTO MEXICO.

Fiscal Year.	Value of Imports.	Import Duty.	Imports from United States.
1872-1873.....	$ 1,768.457.23	$ 659,305.04	$195,597.47
1874-1875.....	1,582,086.99	729,009.11	249.325.34
1888-1889	15,816,924.45	1,558,434.25	784 989.77

The enormous increase of tenfold in the imports in fourteen years is largely due to the fact that within that period Mexico has undergone her greatest era of industrial progress and railway construction. This epoch of railway-building is now being followed by the introduction of iron machinery, agricultural implements, and the use of iron in a thousand methods hitherto unknown in the republic,—a consumption which will show even a greater increase within the next ten years, for in every part of the republic American engineers are introducing the use of iron in numerous factories, mining enterprises, and public works.

With improved transportation, and an abundance of the best quality of easy smelting ores, there is no reason why the manufacture of iron in Mexico should not become a most lucrative industry, especially with the high protective duties. Ten years ago, when Durango was 200 miles from railway transportation, Mr. Birkin-

bine recommended the erection there of a blast-furnace, rolling-mill, machine-shops, foundry, and smithery at a cost of $200,000 or more. In his opinion the manufacture of pig-iron with charcoal would not cost more in Durango than in the United States, and with good management he "could not see a doubt of establishing a modern iron industry at Durango." Already the unusual deposits of Durango, Monclova, and Salomo de Botello have been purchased by American capitalists, and their speedy development is expected.

The value of these ores for mixing with the phosphatic or cold short ores of East Texas and the Alabama regions should not be overlooked. They are the nearest supply for the youthful iron industries at these localities and are not more distant from them than the Lake Superior ore of similar character is distant from the Pennsylvania furnaces in which it is used. But one obstacle prevents this use, and that is the short-sighted tariff regulations between the two countries. In northern Mexico—our nearest foreign neighbor—hardly an article of American manufacture can be found; the small current of the Rio Grande which can be forded at any point is as great a barrier to trade as though it were an ocean. Mexico imports annually and mostly from Europe $37,785,840 worth of manufactured articles and food-stuffs, every dollar's value of which should come from the United States. Her leading exports, exclusive of precious metals, are valued at $14,947,440 and include Hennequin fiber, coffee, hides, vanilla, gums, and tobacco, —articles which, with the exception of hides and tobacco, we do not produce. An exchange of these commodities on terms of reciprocity between the two countries would be of inestimable value to both Mexico and the United States.

Ten years ago Professor Silliman said of the Durango Iron mountain: "The enormous mass of valuable iron ore, thanks to the near approach of the railway of Mexico, is now likely to become of commercial value." Exactly ten years from the publication of his article the Mexican International railway completed its line to the foot of the Durango iron mountain, connecting it by rail with the coal-fields of the Sabinas, and now the prophecies of Professor Silliman and Mr. Birkinbine are on the eve of fulfillment. The Yankee genius that has done so much for Mexico will within the next decade convert the republic from one of the chief iron-importing nations into a great iron-producing and possibly an iron-exporting nation.

ELECTRICITY.

Conducted by Franklin L. Pope.

THE operations of the Board of Electrical Control, to which has been committed the work of placing the electric wires of New York underground, will practically be completed during the present year. Since January 1, 1889, more than 15,000 poles have been removed from the streets of the city, and nearly 22,000 miles of wire suspended upon them has been taken down and replaced by underground conductors. The subways under the streets are of two classes, one for high-tension and the other for low-tension currents, and these are owned respectively by two different construction-companies, to which the electric companies pay a rental for the space occupied by their wires in the subways. The city has an option to purchase the subways at the end of ten years, at an advance of 10 per cent. on the cost of construction. The aggregate length of conductors now in the subways amounts to 33,649 miles, no less than 30,000 of which belongs to the Metropolitan Telephone and Telegraph Co. The total length of high-tension wires used for electric lighting and power purposes is about 1200 miles. The largest number of wires at any one point is at Broadway and Cortlandt street, near the central telephone headquarters. The general plan of construction of the subways is very simple, consisting of groups of three-inch wrought-iron pipes imbedded in cement. Man-holes are provided at every street corner, and the insulated conductors are drawn through the ducts from one manhole to another, and afterwards connected at the ends as required.

NOTWITHSTANDING the hysterical shrieks of the great metropolitan dailies, and their oft reiterated assertion that the people of New York "do not want" and "will not have" the "deadly trolley," the opening of the year 1893 finds the trolley in possession south of Harlem river, and there is every reason to hope that the worst fears of these intelligent and unprejudiced leaders of public opinion will be realized, and that the camel, having, as they phrase it, once got his nose inside the tent, the traditional result will certainly follow. This virulence of clamor against the electric railway is but a repetition of the silly attacks which have been directed in turn against the elevated railways, the Brooklyn bridge, the Broadway surface line, and generally against any scheme whatsoever tending to benefit the city of New York, tending to make it a decent place in which to live and a possible place in which to do business.

THE introduction of electric power for propelling boats on the Erie canal, which has before been suggested, is favorably considered by Governor Flower in his message to the New York Legislature. The canal itself affords abundant water-power at most points where it would be needed, and it would not be difficult to apply the overhead wire and trolley to the propulsion of the boats. Not only would the carrying capacity and speed of transportation be at least doubled, but the saving in cost to the boatmen, who would buy their electricity from the State, and pay only for that used, would amount to a large sum annually. The suggestion is an eminently practical one and ought to be carried out without unnecessary delay.

IN a communication to the *Electrical Engineer*, Mr. G. A. Frei gives some interesting results of experiments made to determine the relative cost to the consumer of light from gas and electricity. He found that the best result with the ordinary gas-burner was 2.5 candles per cubic foot of gas, which, compared with the usual price charged for electric lighting,—1 cent per 50 watt-hours,—would make the cost,

candle for candle, equal to gas at $1.75 per thousand. His results seem to demonstrate pretty conclusively that there is no economy in the use of long-lived lamps. By the use of lamps of higher efficiency and shorter life than those ordinarily employed, enough is saved in 300 hours burning to pay for a new lamp, and the consumer has an abundance of light meantime.

IN the annual reports of the State railroad commissioners of Maine and Michigan considerable space is devoted to the consideration of electric railroads, and especially to the dangers incident to the establishment of grade crossings between these and steam railroads. It is quite evident that jurisdiction over such crossings ought to be given to the commissioners, as the rapidly increasing catalogue of accidents occurring at these points seems to show conclusively that additional safeguards are necessary. It has been heretofore pointed out in these notes that an electric car is more likely to become stalled on a steam railway-crossing than almost anywhere else, a circumstance which largely increases the liability of accident.

THE managers of an important system of street-railways in one of our principal western cities, desiring an impartial investigation of the merits of the storage-battery for electric street-car traction, employed an eminent engineering firm to undertake the work. Their report, which has recently been printed, is chiefly remarkable for the extraordinary lack of trustworthy information which was obtainable from any of the concerns now engaged in exploiting or operating storage-battery cars. To fulfill the requirements of the company's service, it is necessary that each car shall be capable of running 150 miles per day, and fifteen miles per hour, and of hauling two trail cars. This was found to require the transportation of at least 5000 pounds of battery. The storage-battery system involves all the expense of the trolley system except the maintenance of the overhead structure, besides the cost of transporting, maintaining, and handling the batteries. After a study of all the information obtainable both in America and Europe, the conclusion is that "no positive results have been obtained anywhere which would justify any company operating horse-car lines to substitute storage batteries for the horses."

FOR twelve years past the train service of the Boston, Revere Beach and Lynn railroad, a narrow-gage suburban line with a large traffic, has been conducted largely by telephone. A copper metallic circuit is now used, thus avoiding all inductive interferences, and enabling the transmission of all messages to be effected with ease and satisfaction. The superintendent of the road says that, in case of delay and disarrangement of the train schedules, the telephone has proved to be a most helpful means of obtaining at once a "bird's-eye" view of the whole situation, and of affording speedy relief. It is affirmed that with the precautions which have been adopted no serious error has ever been made in the interpretation of an order.

A NOVEL and successful method of illuminating the floats in a night parade was recently employed in Wilmington, N. C. Large numbers of incandescent lamps were used, which were supplied with current by trolleys running upon the overhead wire of the street-railway. Some of the effects obtained were strikingly beautiful, and were in strong contrast with the dismal failure which resulted from the attempt, in the Columbus night pageant in New York, to supply the lamps from storage batteries carried on the floats.

THE death of the venerable German scientist, Dr. Werner Siemens, at the ripe age of seventy-six, leaves a void that will not easily be filled. The briefest mention of the discoveries and inventions of this remarkable man, which have proved to be important contributions to the progress of science and industry, would fill many pages. For more than half a century he has been the most active of workers, and it is not too much to say that no one man has ever contributed so much in the way of practi-

cal applications of electricity as he. The submarine cable, the dynamo-electric machine, and the electric railway will ever remain enduring monuments of his genius.

ONE of the principal difficulties attendant upon the efforts which will doubtless ere long be made to run railway trains by electric power at a much higher rate of speed than has hitherto been accomplished by steam will be that of stopping them within a reasonable distance. A very successful experiment has recently been made at Altoona with a modified type of the Westinghouse brake, the distinguishing feature of which is that a very high initial pressure of the brake-shoes upon the wheels is secured, which is automatically diminished as the speed of the train is reduced, so that practically a uniform retarding force is secured throughout the period of application. It was found that with an ordinary train, running at 60 miles per hour, the train could be stopped within 75 per cent. of the distance required by the present quick-action automatic brake. With the prevailing tendency towards higher speeds, and especially in view of the possibilities, not to say the probabilities of electric propulsion, these results assume an importance which can scarcely be overestimated.

THE British postal authorities are experimenting in London with an automatic letter-box. You drop a penny in the slot and in return get an envelope and a correspondence card, and at the same time an electric bell is rung in the nearest post-office. You deposit your letter, enclosing a special delivery fee of three-pence per mile, and a messenger comes in a few minutes and takes the letter to its destination by omnibus, railway, or cab. Apparently this system might be advantageously adopted in connection with the telegraphic service in places where the district messenger service is not available.

IT is announced that the Post-Office Department will at once make a practical test of an automatic electric despatch for conveying mails between the New York and Brooklyn post-offices. The carriers are to be fourteen feet long and sixteen inches square, with a capacity for 3000 letters. The time of transit is expected to be about five minutes.

A MECHANICAL air-pump capable of producing a high vacuum for the exhaustion of the bulbs of incandescent electric lamps has long been a desideratum. The process of exhaustion by the modified Sprengler mercurial pump is tedious, expensive, and injurious to the health of the workmen. A mechanical pump now in successful use by a Boston lamp manufactory, invented by Adolph Berrenbergh, is said to be capable of exhausting 600 lamps simultaneously in less than one hour, one third of this time being occupied in extracting the occluded gases from the carbon. The mercury pumps hitherto in use are not only limited in size, but require four or five hours to exhaust half-a-dozen lamps. This improvement seems likely to materially lessen the cost of incandescent lamp manufacture.

IN the Calumet and Hecla mines five electric motors of 75 h. p. each are operated at various depths underground, from 800 to 4800 feet. The potential used is 1000 volts.

AN interesting discussion has been going on in the *Electrical Engineer* in reference to the commercial efficiency of alternate current plants for electric lighting. Some of the figures given as the results of actual working show a loss of electric power between the dynamo and lamps approximating 40 per cent., while others reduce the loss to as little as 15 per cent. The remedy, as clearly pointed out by some of the writers, is to use transformers of modern make and high efficiency, and to make the transformer units as large as circumstances admit of. The question of the efficiency of alternating current plants, and indeed of electric lighting plants generally, has not received the investigation which its practical importance demands, and we are glad to see that it is beginning to attract attention.

THE work of harnessing the remaining unused water-falls of New England, and of distributing the power for industrial purposes by electricity, is going forward with encouraging rapidity. Works are now in progress at Sewall's falls, on the Merrimac, four miles above Concord, N. H., which when completed will give about 5000 available h. p. A large amount of electric lighting and power for miscellaneous manufacturing purposes has already been contracted for by the owners of the plant.

THERE appears to be a veritable boom in the electric railway business in Connecticut, if one may judge by the fact that forty-one applications for franchises for projects of this character are awaiting the action of the legislature.

THE Quebec Electric Light Co. have purchased the entire water-power of the Montmorency falls, which is estimated at 18,000 h. p., and will utilize it for furnishing electric light and power to that city.

EXPERIMENTS recently made by Mr. Luquer, on materials used for the insulation of electric wires, show that silk is inherently a much better non-conductor than cotton, owing largely to its capacity of resistance to the effects of moisture. Shellac is found to largely increase the insulating properties both of silk and cotton, but cotton without shellac cannot safely be relied upon.

IT is announced that a public exhibition of Professor Elisha Gray's telautograph will shortly be given. This apparatus reproduces all messages in fac-simile, at any distance and with great rapidity. It is open to question whether this feature alone is one of any especial commercial importance, but it is obvious that, if a written message could be, as it were, put into a hopper, and automatically reproduced a thousand miles distant in a few moments, in a condition to be placed at once in an envelope and delivered, an enormous advance would have been made in the direction of rendering the telegraphic service as cheap and universal as that of the mail. The highly skilled hand-labor employed is the occasion of the greater part of the actual cost of sending and receiving each message, an item which, in case the telautograph should equal the expectations of its friends, will be largely done away with.

IT is reported that the business of the long-distance telephone line between the eastern and western cities is much larger than had been anticipated, and that it has been found necessary to put up additional wires at once between New York and the principal intermediate cities.

AN electric kalsomining machine is in use on the World's Fair buildings, by the aid of which, it is said, two men can cover as much surface in a day as twenty or thirty men working in the ordinary way. The machine consists of a rotary pump combined with an electric motor, and having a hose through which the liquid kalsomine is conveyed to a nozzle having a wide opening about the thickness of a card, and being mixed with air is ejected in the form of spray.

A TRANSFER-TABLE is in process of erection in the annex of the transportation building at the World's Fair, seventy feet long, fourteen feet wide, and having a capacity of 100 tons, which is operated by a 30 horse-power electric motor, with the necessary regulating and reversing devices. The speed may be varied from 250 to 500 feet per minute. Current is supplied from a pair of trolleys which run on conductors laid in a pit underneath.

THE electrical condition of the cables in the subways in New York city, especially that of the high potential electric-lighting circuits, is said to be very satisfactory. After three or four years' use, there appears no indication of deterioration of the lead-encased cables, the elasticity of the India-rubber coating of the wires being apparently as perfect as when the cables were first laid. To prevent injury to the lead from ammoniacal salts, which are sometimes present in the soil, the metal is alloyed with about three per cent. of tin, and,

in addition, is preferably coated with tin on the outside. The insulation of the high potential circuits is tested every week. So far as known, there has never been an instance of injury to the underground lines in New York from lightning.

DURING the present winter electric heaters have been applied with satisfactory results to a large number of electric street-cars in Canada and in the northern parts of the United States. Although electric heating is by no means an inexpensive luxury *per se*, there are nevertheless many instances, of which the above is but one, where its convenience of application without waste are more than sufficient to offset its increased cost. In large laundry establishments also electrically-heated sad-irons have been found to possess many advantages. The iron is readily maintained for hours together at exactly the proper temperature to ensure the best results, while the saving of the operator's time in changing irons and running to and from the heater is no inconsiderable item.

ON the electric street-railway line in Utica, N. Y., a special trolley-wheel is used for cutting accumulations of sleet from the overhead wire, the performance of which has been very satisfactory. It may be substituted for the ordinary trolley-wheel in a few moments, when necessary, and is a much more effective expedient than that of applying tallow to the wire, as heretofore practised in such cases.

IT is very evident that the present tendency among electrical engineers is towards the employment of much higher pressures than have hitherto been considered safe, especially where alternating currents are used. As one writer very pertinently remarks: "As we are compelled to convert, let us convert for a purpose. Let us employ a primary pressure of 2000 volts at least, instead of 1000. So far as danger to human life is concerned, if 1000 volts will kill, as has been asserted, 2000 volts cannot do any more." With the perfection which has now been reached in the construction and insulation of electrical machinery, there would seem to be no good reason why the higher voltages should not be used. The change would enormously enhance the economy and utility of the systems of distribution now most in use.

IT requires nearly 3000 incandescent lamps, to say nothing of a considerable number of arc lamps, to light the works of the American Screw Company in Providence, R. I.,—more than enough to illuminate many an aspiring town.

ON many of the electric-motor cars now in use the motor-man is required to handle two separate levers, one for reversing and the other for varying the speed of the car. This seems to be an unnecessary and dangerous complication. When running at the rate of twelve or fifteen miles per hour with a heavy load of passengers, and possibly with an equally heavily loaded trail-car, if a pedestrian inadvertently steps on the track, there is not much time for the driver to cut off the current, throw the reverse lever, and again apply the current in order to stop the car independently of the brakes. The arrangement whereby the reversal is effected by a single lever, as in the motors formerly built by the Sprague Company, seems certainly much to be preferred on the score of convenience and safety.

THE manager of an extensive photo-engraving establishment in New York, in speaking of the varied applications of electricity in the practice of that art, says that he uses it not only for lighting throughout the building and in the dark-rooms, but also for driving printing-presses, saws, burnishing-machines, pumps, ink-mills, fans, etc. It is also used for heating, ventilating, electrotyping and depositing metals, and serves also as a substitute for the sun in printing plates on dull days. Experience has shown, moreover, that the economy over the old methods is no small item, to say nothing of the convenience of having such a useful servant always at hand to perform every required duty.

MECHANICS

Conducted by Leicester Allen.

OF the machinery business during the past year and the outlook for the present year a most cheering report can be gathered from numerous communications that have appeared in recent issues of the *American Machinist*, a paper which perhaps ranks as the highest exponent of the manufacture of machinery published in the United States. If a large number of letters from other manufacturers that are promised to follow shall be of the same tenor, it is evident that the business is passing through a period of almost unexampled prosperity. The letters are, for the most part, from leading and representative houses in the trade, which gives to the statements made such force and authority as to justify a highly optimistic view of the future of American machine-building. It has been a praiseworthy practice with the paper named, at the close of each year, to obtain these individual statements of the state of the trade; and they together give, perhaps, the most reliable data obtainable upon which to form an opinion upon the probable condition of the business for the following year.

WOOD-WORKING machinery manufactured in the United States is finding a profitable and growing market in that part of the world where it would seem that American enterprise may expect increasing demand for other kinds of machinery and utensils. The New York *Evening Post* quotes a letter of the Hon. T. H. Anderson, United States minister to Bolivia, addressed to the Department of State, as saying "that the industry of working wood by machinery in South America is a growing one, and the trade for all classes of wood-working machinery is given to the United States." And he further says that "the Egan Company, of Cincinnati, Ohio, control over 50 per cent. of the trade in this class of goods, simply as the result of their enterprise in successfully placing their superior goods before the South American buyers." The vast natural resources of the South American continent cannot much longer remain undeveloped, and an important result of the surveys of the Pan-American Railway, of which Mr. J. D. Garrison gives such a pleasing and graphic description in THE ENGINEERING MAGAZINE for January, will be an increased appreciation of the stores of wealth now waiting to reward commercial enterprise intelligently directed in that quarter of the world.

ONE of the best papers upon any mechanical subject that has come to the editorial desk for a long time is that read by Mr. W. S. Rogers at the November meeting of the New York Railroad Club, and printed in the December number of *Locomotive Engineering*. The subject discussed in this paper is "The Location of Machinery in Shops," a problem with which every superintendent of machine works has to grapple more or less, and one which, as all will agree, taxes foresight and judgment as much as or more than any other duty of the supervising engineer; for all competent superintendents are aware that upon the arrangement of machines, judicious or otherwise, will depend either a large saving in handling work that is to be tooled, or a large yearly expenditure that could have been avoided by more skilful planning. Moreover, the usefulness of a machine-tool, apart from the saving effected in handling, will depend very much upon its position with reference to other tools. In a shop where only regular manufacturing is conducted, as of pumps, steam-engines, or tools for the use of other shops, the problem is perhaps not quite so difficult as in a jobbing shop to which comes all manner of repair-work, and divers orders for construction of machinery, much of it of an entirely new and experimental

character. Mr. Rogers, in his paper, confined his remarks to locating machinery in locomotive-shops; but much of what he said is of general application to all manufacturing establishments. The entire paper is good enough and of practical value enough to be quoted. As that is impossible here, only one or two samples of its tone must suffice. Speaking of the tool-room, which Mr. Rogers paradoxically calls "an important adjunct and an absolutely necessary evil," he says, "the space it requires alone makes it the hardest to locate; and, as a general rule, it is the creator of more dissatisfaction than any item connected with the whole plant."

A friend of mine once asked my opinion about the best place to locate a tool-room in the new plant he had established. I advised putting it in the northeast corner, and he did. Three years later I met him, and in the course of our conversation I inquired about the convenience of the tool-room location. His reply fully illustrated the uncertainty always existing in the mind of a practical mechanic when this department of a shop's equipment demands attention. His answer was: "I have moved it to all four corners of the shop since I saw you, and now have it in the center of the place, and still it doesn't fit. My general manager suggested recently that I jack it up and run a set of trucks under it and take it out of doors next."

I have seriously thought that, when it falls to my lot to again locate a tool-room, I will divide it up and put four or more smaller ones in as many parts of the plant, with the small hand-tools in each necessary for the machines in their vicinity.

And again, speaking of arrangement of planing, boring, and drilling machines for cylinder work, he says:

If the planer is located near the boring-lathe and in proper position, and the radial drill is also within convenient range, very little transient labor will be required to perform the three operations [planing, boring, drilling]. We also find that the man on the boring tool can also push along the planing and oversee the drilling, thus keeping all the machines in operation with the minimum of labor and as rapidly as if it was done in the old way, with one man to each machine and one-third of them waiting for work to reach them, as would be the case if they were isolated.

A hint at labor economy is contained in the above quotation that may find a much wider application than the author gave it. To make the application general, it may be said that succession in processes or operations means succession in the use of appliances or tools, and that, while succession will suggest order to an orderly mind, the *best* order is the thing to be studied; and the best order cannot be reached by widely separating closely related terms of a series, either in mathematics or in mechanical operations.

INDEPENDENT of perfecting the planes of sliding surfaces on cast iron and steel, scraping in the usual manner hardens them by burnishing to an astonishing degree. Hence, even if an expert mechanic and a fine planer should be able to make two sliding parts fit together with smooth and true surfaces, it is economy to scrape them for the improved density to which that practice refines such surfaces. It is probable, however, in the evolution of tools, that means to get this condition of surface will be accomplished eventually on the planer or milling-machine, and it seems probable that this will be accomplished about as soon as means are found to secure work to tools in such a manner that its elasticity will not be disturbed, so that a job of work will retain the shape to which it is machined after it is relieved from the holdings.

THE law of evolution has its very best mechanical exemplification in steam engineering. Since the days of Watt there have been no startling innovations in steam engineering, no sudden and rapid flights of genius, not even the discovery of many principles unknown to Watt and the scientific men of his day. Yet the growth has been magnificent. One advance has led to others that have been in turn the parents of future improvement, and it may be said that there has been neither retrogression nor pause in all this course. Naturally, in view of the high pressures now carried and the extent to which the expansion of steam has been developed, in double, triple, quadruple, and even quintuple expansion engines,

it looks to most of us as though we had about reached the limit of progress. One hesitates, in view of all the mechanical surprises of the past, either to affirm or deny a belief that the limit of progress in the development of steam power has been nearly approached. It is better and wiser not to enter either the realm of conjecture or of prophecy, lest we find that hind-sight will fail to justify our fancied foresight.

AN instance of the highest engineering skill, and the use of the best modern appliances in the design and arrangement of a boiler-house for a manufacturing plant, is that at the soap and glycerine factory of Curtis Davis & Co., at Cambridge, Mass. This example of good practice is too instructive not to receive some notice in such an exponent of progress as THE ENGINEERING MAGAZINE; although without the aid of illustrations such a notice will be inadequate. The object sought in the design was to secure the highest economy known to be attainable in the production of steam for manufacturing purposes with horizontal return tubular boilers, the latter being selected in preference to other boilers, not because they were supposed to represent the most advanced boiler-construction, but for other reasons relating to the special industry in which they are employed;—most probably because their water-holding capacity is larger than that of other types. Entire control of the design and construction was entrusted to the engineering firm of Westinghouse, Kerr & Co., of Boston, with instructions to include in the design and outfit every appliance that would reduce the cost of steam production to a minimum, whether related to the consumption of fuel or to the expense of attendance. There are eight boilers, each of 125 horse-power, set in two batteries, each containing four boilers and arranged to deliver the gases of combustion into a centrally-placed, brick-lined, boiler-plate smoke-stack 72 inches in diameter and extending 17 feet above the roof. The necessary draft is effected by an exhaust-fan which sucks the gases of combustion through a Lowcock economizer, one of which, placed over each boiler, extracts all the heat from the waste gases and restores it to the boiler again. One reason for adopting the forced draft was the fact that without a very large expense for pile-driving a suitable foundation for a chimney of the natural-draft variety was not available; however, it is probable that a higher economy is obtained by the method employed than could have been attained by the natural-draft system, even had there existed no difficulty in getting a good chimney foundation. The coal is fed to each boiler by a Roney mechanical stoker, to which coal is conveyed through a chute from an overhead coal-bunker placed at the front of each battery of four boilers; these stokers continually supplying fuel to the grates as required. All the appliances of the boiler-room are in keeping with the carefully-designed setting and arrangement of the boilers, including gages, pumps, and water-meter. Duplicate feed pumps, each of capacity to supply all the boilers, are provided. Of two other pumps one is used for elevator purposes, and the other is kept slowly acting so as to be ready for instant activity in case of fire; each of these being alternately used one day for elevator work and the next day, as described, for fire-service. There have been some fine illustrations of this boiler plant printed in the technical weeklies, and no doubt such an example of refined practice in steam generation will incite greater attention among manufacturers to possible economies in boiler-houses.

A NEW material manufactured in Germany and called "xylolith" ought to be valuable for use in lagging steam-boilers and steam-cylinders, if all the properties claimed for it can be substantiated. The name is from two Greek words respectively meaning wood and stone; from which it may be reasonably inferred that it partakes of the nature of both the materials from which the name has been suggested. It is made of sawdust by treatment with some ingredient or ingredients, the process being a secret with the manufacturers. Its leading properties, which seem to peculiarly fit it for insulating purposes, are stated to be non-inflammability, non-conducting power,

imperviousness, freedom from shrinkage, and susceptibility to a high polish. These properties, added to the fact that it is cheap enough to compete with wood in architectural uses, are just the requirements for steam lagging, and there appears to exist no mechanical difficulty in applying it to this use, since it can be worked like wood, according to descriptions of it that come from apparently reliable sources. Whether it is really superior to sawdust compositions of American manufacture that have been put on the market only a competitive trial can determine; but its qualities, as described, appear to be quite different, it being harder and stronger, and capable of being polished.

A NEW system of heating railway cars, called the "multiple circuit system," has been introduced by the Consolidated Car Heating Co., of Albany, N. Y. The principle of the apparatus is the heating of circulating water by steam from the locomotive, the heated water being made to flow through heater pipes placed in the cars to be warmed. The water is heated in a drum placed beneath the car to be heated. From this drum supply-pipes lead off to pipe-heaters placed on each side of the interior of the car, return-pipes leading back to the heaters analogously to the similar pipes used for hot-water heating in buildings. The water in the drum is heated by steam passed through corrugated copper pipes, of considerably smaller diameter than the drum, which are inserted through the head of the drum; these being united at their innermost ends by return bends, the inflow and outflow of steam and condensed water are both at the same end of the drum. To prevent freezing, the circulating water may be converted into brine by the addition of salt. The advantage in this system which will appeal chiefly to mechanics who construct heating apparatus is that, each car having an independent hot-water system of its own, the hot-water circuit is comparatively short and the resistance to circulation small. Of course the steam circulation must be continuous from car to car. The system in some of its features so closely resembles the original car-heating apparatus invented by Mr. E. E. Gold and manufactured by the Gold Car-Heating Co., of New York city, as to suggest the possibility that the patents of the last-named company have been infringed upon. A water-heater may be placed in the car and connected directly with the heater pipes or with the drum beneath the car, thus affording a means of heating the car independently of the steam connection,—a great desideratum when cars are stalled on a track from any cause, or when disconnected and side-tracked in waiting to be picked up by another train.

AN example of the application of electric motors for driving machine tools was noticed in this Department last month. Another conspicuous example has recently attracted attention abroad. The installation is the small arms factory at Herstal, Belgium, erected for the Fabrique Nationale d'Armes de Guerre, in Liège, which company, having been commissioned to fill a very large order for Mauser rifles for the Belgian Government, found it expedient to build an entire new plant for the prosecution of their business. At first transmission of power in the usual manner by means of line-shafting, countershafting, and belts was contemplated; and considerable progress in carrying out the original plan had been made when the great advantage in such an industry of driving tools independently became so apparent to the management that it was decided to "hark back" and reconstruct the plant on the plan of driving the entire works by electric motors. What this simple statement means can best be impressed upon the imagination of the reader by the facts that the area covered by the works is twenty acres within a very small fraction, the power required to be distributed to the large number of machine-tools in various parts of this extensive plant is not less than 350 horse-power, and that the factory is expected to turn out, on the Belgian Government order alone, about 100,000 rifles in twelve months. To meet the above-named requirement for power, and also to provide for an increased demand, a single dynamo of 500 horse-

power is placed upon the shaft of the engine, an example of putting one's "fish all in one bucket" that seems hardly justified by the saving in cost over two dynamos, each of 250 horse-power, which it is stated might have been put in at an increased expense of about $6000. The speed of the engine is sixty-six turns per minute. All the electric plant has been put in by the Compagnie International d' Electricité of Liège and is said to meet in every way the expectations of the designers and requirements of the industry. Such notable innovations as this point clearly to a time in the near future when countershafts and belting will have been substantially superseded by the silent, motionless wire that may take any indirect course to the point where power is needed, and in doing so not only occupies enormously less space, but also wastes less power. In the works at Herstal a total efficiency of 72.5 per cent. of the indicated horse-power of the engine has been computed by *The Engineer* (London) as imparted to the motors of the tools. It is extremely doubtful whether this economy in transmission can be excelled, even if it can be equalled, by any other system of distributing power to a large number of machines.

As regards engines and boilers for central stations of any considerable size, no less an electrical engineer than Thomson has recently gone on record in favor of cross-connected twin-engines of low speed and water-tube boilers, of which type the well known Babcock and Wilcox boiler has been a leading exponent for a quarter of a century. He states that there can be no longer any doubt as to the superior economy of the class of engines named over that of the best high speed engines manufactured, and thinks the latter "can only be recommended for isolated and small plants, where slow running single engines would be apt to cause a fluctuation in the lights when passing centers." He advocates the use of double, or even triple, expansion, when the boilers can carry high pressure, and this is probably the main reason for his advocacy of water-tube boilers, which can safely generate steam at any pressure that could be used for engine propulsion. So the boilers that can safely supply steam at pressures five or six times as great as were in the last generation thought practicable, and the multicylinder engines that can use much more of the heat force stored up in steam, are each reacting upon the business of manufacturing the other, and methods in steam engineering of twenty or even fifteen years ago are becoming obsolete.

In working with copper pipe a difficulty is often met where lengths must be joined to valves or fittings by means of flanges, because the joint between the cast flange and the rolled pipe cannot be made perfect. A device to mitigate this evil recently introduced forms the flange casting with projecting lugs which come up around the outside of the pipe, and thus increase the surface for the adhesion of the brazing material. A plan which has been adopted at the works of the Great Eastern railway shops in England consists in pressing up the flange end on the solid material of the tubes in the copper work, so that the union nut used for the purpose of making connections in small work can be fitted to the thread cut upon the upset end. This of course applies to work smaller than that where the flange becomes the proper device for the joint.

It is assumed that readers understand that this department includes the entire range of mechanical arts. Any information relating to important advances, discussions of principles or facts pertaining to these arts, or useful suggestions related to any branch thereof, forwarded to the editor, will be thankfully received and duly considered.

ARCHITECTURE.

Conducted by Barr Ferree.

IT is much the fashion to regard the annual exhibition of the Architectural League of New York as the most important architectural event of the year. Undoubtedly it should be; and this year especially, when it was held for the first time in the spacious and commodious galleries of the American Fine Arts Society, there was more than usual inducement to make it so both in fact and in name. But then things are not always what they seem, nor do they always seem to be what they are. Unless the methods heretofore pursued in forming these exhibitions are materially changed, they will cease, before long, to have any importance save what may be given them socially. This element in itself is not to be despised, and is worthy of the very greatest encouragement, but in looking after the social side of its exhibitions the League should not neglect the great opportunities it enjoys for the betterment of the public taste, for the elevation of the architectural standard, and for teaching the real meaning and purport of architecture. It would seem to be a proposition so reasonable as to require no argument to enforce it that these annual collections of drawings should be thoroughly representative of the architectural work of the current year. Yet the exhibition which has just closed—the eighth of an increasingly successful series—could in no sense be taken as representative of present work in any department. Not only was it deficient in illustrations of new and important enterprises, but many of the leading firms were totally unrepresented by drawings. If this indifference or lack of interest continues, the League exhibitions will soon lose any representative value, if they have not already done so. Each year brings new and strange names to the catalogue, which seem to be fast crowding out the older ones. And this does not by any means indicate an increase in the membership of the League, or an extension of interest in its work. It means simply that the value of these collections is more appreciated as a means of advertisement by the younger men than by the older; that well-established firms will not take the time and trouble to prepare drawings for exhibitions, if indeed suitable drawings for that purpose are always to be had; that, finally, there does not exist among the older men a due perception of the advantages the League exhibitions offer for telling the public what architecture is, and thus, to a very considerable extent, helping to raise the public interest in this great art, and properly mold public appreciation of it.

Nor is this the whole of the matter. Just as year by year new names replace old ones, so more and more is there a tendency to make an exhibition of pictures as distinguished from architectural drawings. New York is abundantly supplied with exhibitions and societies for the display of artistic pictorial illustrations and fancies: it has no good suitable provision for industrial art, and hence the miscellaneous collections which are invariably tacked on to the League's collections may have some real value. Apart from this, however, there is no reason at all why American architects and New York architects in particular should not be able to produce a real architectural exhibition. Certainly the material is abundant; work has seldom been so active as now, yet no one would have imagined such to have been the case from an inspection of the pretty pictures which made up a large part of the recent exhibition, if, indeed, they did not form its major portion. It may be too soon yet to introduce working drawings into a collection intended primarily for the great unlearned public, but an architectural exhibition in which plans and other architectural forms of expres-

sion are chiefly conspicuous by their rarity is in no sense entitled to so honorable a title as architectural. Of pretty sketches and picturesque drawings the exhibition possessed a plenty, though the least architectural of the visitors must have wondered, if they looked at the drawings at all, how some of the strangely-roofed cottages and other phantasms—though they did not resemble the typical phantasm, be it said in justice to all concerned—with which the walls were covered were arranged internally. Apart from these cottages and some other lesser work there was little architecture to see. It is true the exhibition included a number of drawings of the State buildings at the World's Columbian Exhibition, but these were more interesting as examples of things that had better been left undone than of things done. In high office-buildings, which are unquestionably the most important and characteristic structures of the day, only a few drawings were shown, and most of these were competition drawings, not uninteresting because chiefly unsuccessful, but sadly suggestive of indifference on the part of architects busily engaged in erecting actual examples. The League exhibitions should be to every architect, great or small, firmly established or just starting into business, as important and valuable as the regular yearly exhibitions of paintings are to painters. If nothing better than the Eighth exhibition can be produced on present methods, no time should be wasted in preparing others which would remove the glaring errors and total insufficiencies now so manifest. A useful addition to the catalogue, by the way, would be the insertion of the number of each architect's drawings after his name in the list of exhibitors. Any one looking for examples of a particular architect's works would thus be able to find them without the trouble of reading through the whole catalogue.

THE Chautauqua Literary and Scientific Circle is extremely fortunate in having as director of its courses in art so accomplished a scholar and profound a student as Professor William H. Goodyear. His discoveries in the Lotus origin of Egyptian art-forms not only rank among the most notable contributions to art-history made by any scholar, but have placed him in the front rank of living Egyptologists. His papers on the "Influence of Greek Architecture in the United States," prepared for the present American-Greek year of the Circle, and printed in *The Chautauquan*, are of unusual interest and contain much valuable information. They will doubtless do much towards emphasizing the real nature, extent, and importance of this movement in American architecture. Greek architecture in America, so far as the copying of Greek forms and the building of edifices imagined to be copies of Greek temples are involved, has long since died out with us, but it is nevertheless useful to go back to the first half of the century, when this art flourished, and note not only its development at that time, but its origin and survivals at the present day. This work Professor Goodyear has done in a thoroughly admirable manner, and as his papers are illustrated with numerous photographs they form a valuable contribution to the history of architecture in America,—a much better form of expression, by the way, than "the history of American architecture." But notwithstanding the general excellence of these papers, there are one or two points to which we would take exception. We are not quite prepared to follow Professor Goodyear when he says: "We build a Greek portico when we imitate the Greeks, or when we imitate people who imitated the Greeks, or when we imitate people who imitated people who imitated the Greeks." Greek is Greek; of that there can be no question. But Roman is not, or what came after the Roman. The Roman may be based on the Greek,—absorbed is perhaps a better word,—but it is not Greek any more than the English language is Anglo-Saxon simply because it rests on it. Professor Goodyear does not mean that Roman art is identical with Greek, or that modern reproductions are Greek; all that he intends to say is that Greek forms were used at different times by different people in different ways.

AS a matter of fact, since the extinction

of Greek architecture upon Greek soil, there has been no Greek architecture built anywhere. Greek architecture, no more than any other living architecture, is the reproduction of forms, but a living, real art, in which the *spirit* is as powerful in producing results as the *form* in which they are clothed. Hence we think Professor Goodyear creates a somewhat confused impression in presenting illustrations of such un-Greek buildings as the Chicago City Hall, the Equitable building in New York, the Roman Catholic Cathedral of Philadelphia, the City Hall in the same city, the White House at Washington, and various Colonial residences as examples of the influence Greek architecture has had upon the buildings of this country. They contain columns and entablatures and pediments modeled, after a fashion, on the Greek, but, as Professor Goodyear himself admits, the Italian Renaissance was a Roman Renaissance, and there would seem to be no good reason for attributing these buildings to Greek origin. They are examples of the reproduction of Greek forms, not survivals of Greek architecture. They were the product of the Greek revival in a certain sense, but it is hard to get further from the Greek either in spirit or in form than in that wonderful structure known the world over as the new City Hall of Philadelphia. Even Girard College, which Professor Goodyear calls a Greek temple, is not Greek, but Roman, there being no temple actually Greek built with the Corinthian order used in it, the temple of Jupiter Olympus at Athens being really a Roman building on Greek soil. In this connection also it may be mentioned that the professor falls into an unconscious error in criticising the story above the pediment of St. George's Hall, in Philadelphia. This is a very recent addition to the building, and was in no sense a part of the original design. It is somewhat strange that, admitting as he does, to membership in the Greek family, so many buildings generally classed as Renaissance, Professor Goodyear should have ignored the present Renaissance revival. It would have been interesting to learn his explanation of this most recent architectural fashion, especially if he would attribute it, as it must inevitably be attributed, to the influence of the architectural schools. This important chapter in his studies remains to be written, and in neglecting it he neglected also to add to his illustrations the *Mail and Express* building of New York, which, notwithstanding some obvious faults, is clearly one of the finest examples of the Renaissance in the United States.

THE Brooklyn Institute, whose proposed new Museum of Arts and Sciences and the competition connected therewith has been already noted in these pages, has issued a series of circulars bearing upon the matter. Having determined upon the wrong method of securing a building,—for it is hard to believe that a dozen or more architects in this country have had the special training to fit them to the work of museum-designing,—the Institute proceeds to balance the question by preparing an elaborate and comprehensive scheme of competition, admirably detailed, thoroughly explicit in all important particulars, and forming, on the whole, a valuable and interesting contribution to the literature of museum-design. The instructions to the architects call for a four-story structure, with courts or not, as may be decided by the competitor, an astronomical annex, power-plant, etc. While the necessities of the Institute are minutely set forth, and very properly, the architect is given a great deal of freedom. The trustees have not sought to follow the planning of any present museum building, —a most wise conclusion, since there is but one building in the world that can serve as a model for a successful museum. This is the National Museum at Washington. Architecturally, of course, this structure is an abomination of abominations, and as unartistic as any building can well be. But it is thoroughly convenient for its present purposes, and what other criterion is needed in estimating the value of a museum building? Every exhibit is on the same floor; it is provided throughout with movable partitions, thus permitting any part to be enclosed or thrown into an adjacent part; every object is on wheels, or in a cabinet on wheels, and at any

lecture anything and everything can be rolled to the lecture-room with little trouble and expense. The admirable arrangements and practical purposes of this museum far exceed that of any similar structure in America, if they do not surpass the world.

IF Mr. Cornelius Vanderbilt has read all the comments, sermons, discourses, suggestions, mountains of advice, reams of wisdom, and worlds of foolishness which have been poured forth on himself and a long-suffering public anent the burning of his cottage at Newport, he not only now knows more about fires in dwellings than any other person living, but doubtless wishes fervently that he did not know so much. It is not the intention of the Department of Architecture to add to Mr. Vanderbilt's woes in this direction, or to refer to an event which has been written up in every newspaper and technical periodical in the United States. THE ENGINEERING MAGAZINE may well be permitted to end the procession. It is seldom that a fire in a domestic dwelling attracts so wide attention as Mr. Vanderbilt's did, yet every day lesser calamities are happening in all our great cities to people much less able than he to afford the loss. Whether the fire in Mr. Vanderbilt's cottage actually arose from a defective flue or not, there can be little question but that many domestic fires, and many fires not domestic, have their origin in a carelessness little short of criminal. Just at this time the cities of Milwaukee and Brooklyn are suffering from an abnormal number of fires. Warehouses, factories, dwellings, almost every grade of building, have suffered recently, and so numerously as to direct the active attention of insurance-men to them, with the result of a considerable increase in rates. All manner of excuses have been put forth. Fire fiends, badly-equipped fire-departments, improper construction have come in for their share of the blame. Doubtless all are responsible in a measure, yet it seems one of the strangest things in the world to fasten the responsibility of a number of fires in any one city upon its fire-department, be its equipment ever so bad or out of date. A deficient fire-department may help the seriousness of fires by not rendering proper service or in not being provided with adequate apparatus, but it can have nothing to do with the number of fires. Neither is it fair to censure the architect and the builder. Brooklyn's epidemic is a recent one, though the city is by no means new. A more satisfactory explanation, certainly in the instances of domestic dwellings, is the unutterable carelessness of people with fire and flame. So long as the house does not burn down every improper use of fire is all right; the moment the catastrophe occurs, the fault is looked for everywhere, save in the nearest place. Cities afflicted with numerous fires had better issue instructions to the people on handling them, similar to health bulletins issued in times of pestilence, than spend their time in investigating the evil doings of architects and buildings, or bewailing the insufficiency of the fire-engines.

THE Eastern readers who took the trouble to glance through the yearly records published by the Chicago papers at the first of the year could have experienced no other sensation than amazement at the growth of our great western metropolis, unless it was to question the healthfulness of this progress. Chicago after the World's Fair will be even more interesting to students of municipal growth than before, were such a thing possible. Now everything is to come, and it is hard to believe that speculative tendencies have not more or less influenced Chicago real estate and building during the last few years. Yet there can be no doubt but that much of this expansion is real and natural. No one can possibly admit for a moment that the Western Union Telegraph Company would have paid $1,500,000 for a site for a new building if the cautious, conservative men who handle the affairs of that gigantic corporation were not fully satisfied they were getting their money's worth. Nor is it supposable that the Auditorium Hotel Company would have built an Annex to their present great building at a cost of $1,000,000 for Fair patronage only. The

most extravagant Westerner would not have put so much money into a substantial structure for a few months' returns only. Judging Chicago's growth by the estimates based on building permits and on real-estate sales, the expansion during the last year has not been out of proportion to that of the year before. That the Fair has given the city an immense impetus is proved by the swelling of the totals of new building values from $25,065,000 in 1889 to $47,322,000 in 1890, to $55,360,000 in 1891, and to $65,403,000 in 1892. This is coming close to the figures for New York, being within $10,000,000 of the total for 1891 for the latter city. As it is, Chicago's new buildings in 1892 have more than three times the value of its new buildings for 1888, an amazing increase for so short a time. Whether permanent or not, whether "legitimate" or not, the record is one of which not only Chicago may be proud, but the whole people of the United States. Before such a showing the carping critics of less progressive communities, whose eastern horizon is bounded by the Atlantic ocean and their west by their back fences, may well preserve a discreet if not joyous silence.

THE importance of the relationship between architecture and landscape gardening scarcely receives the attention it deserves in this country, or which it receives abroad. Yet there is no reason at all why it should not be an important and profitable art with us. Our country is filled with wealthy men anxious and willing to surround themselves with all that is rare and beautiful, and a well-designed and well-kept garden or country estate is a possession in which the most ardent lover of the beautiful may take great satisfaction. Quite recently an extended controversy arose in England on this very question, though in a different sense than it would have here. With us the question is rather garden or no garden; abroad it is a formal garden or a natural one. Both sides have their advocates, and under certain conditions both sides have their merits. One of the most interesting contributions to the controversy has been furnished by Mr. Robinson, whose little book, "Garden Design and Architects' Gardens,"* although hampered somewhat by being in the form of reviews of two works in favor of the formal garden, is full of interest. The formal garden is, as its name expresses, a formal arrangement of trees, flowers, and shrubs, extending even to trimming the former into strange and wondrous shapes, in making walls of foliage, and otherwise distorting nature's handiwork. The natural garden, on the other hand, by no means leaves nature to itself, without the slightest thought of training from the human hand. As Mr. Robinson well says, if a great park were left wholly to nature, it would, in a generation, be scarcely other than a wild wood. The proper medium lies rather between the two, though the beauty of the formal garden is an artificial beauty, not a natural one. But wisdom and discretion are needed in the making of a garden as they are needed in the building of a house. And further,—and this is the great lesson to be learned from the controversy,—the work needs to be done by trained hands and by trained minds. Not every man can see the natural opportunities in every bit of landscape, nor can every one take advantage of them. In the United States there is but one firm of national fame engaged in this sort of work. There would seem to be ample and abundant opportunity for many competitors.

* *Garden Design and Architects' Gardens.* By W. Robinson. London: John Murray, 1892.

INDUSTRIAL CHEMISTRY.

Conducted by Dr. R. A. Witthaus.

THE position of the college chemist in technical practice has been lately ably discussed by Mr. Ivan Levinstein, chairman of the Manchester section of the Society of Chemical Industry. The question is always one of interest, and is yearly becoming of more and more importance as the "rule-of-thumb" men are gradually dropping away and their places, or at least their positions, are being filled by the younger college graduates. "Are the latter competent?" is often asked, and many are the answers given. Undoubtedly in many instances the college-man has not given satisfaction, and hence not a few able practical men are loud in their condemnation of the whole college system. That this is unjust and narrow there is hardly need to take time and space to argue; but what is wrong? Why has this belief been so general? Mr. Levinstein speaks particularly of the chemist in the dyeing industry, but his remarks apply equally well to any branch of chemical manufacture or metallurgy, and we will quote freely from his address, believing it to be a most able presentation.

"No doubt students on leaving [college] possess a fair amount of knowledge, but of a kind a great deal of which is never required in practice and much that is required they have never been taught. The reason for such a failure is very evident. Success in dyeing, printing, and the accessory arts does not depend solely upon a sound knowledge of chemistry, but to a large extent, just the same as applied chemistry in general, upon chemical engineering. Hitherto, however, the student, after having gone through a science and a so-called experimental course in which no opportunity is afforded of becoming acquainted with the engineering part of his profession—his experience principally extending to the handling of beakers, glass cylinders, china basins, a few grains or grams of drugs and coloring matters, and correspondingly small quantities of yarn and cloth, has found himself, on entering a dye- or print-works, in a similar position to a cow before a turnstile, not knowing where to turn or how to move; he feels that every ordinary workman in the place knows more about the complicated machinery and other appliances before him than he does. The consequence is that the foreman or manager looks over his shoulder, and the principal soon gets disgusted with his new acquisition from which he had been promising himself so much." Thus the position is outlined, and we are sure many a technologist will recognize it; possibly he has been the same young chemist, bewildered by his own suddenly discovered ignorance on subjects with which he had deemed himself familiar and entirely capable to superintend. Then there come a few years of hard work, harder than ever had been dreamed of in college days, and finally our chemist is graduated, without a degree this time, but now a master and leader.

Mr. Levinstein strongly advocates the introduction of more practical education. "We must have the school workshops equipped with the very latest and most modern machinery of this or any other country, which must be kept on a level with the progress of discovery and invention. Undoubtedly this is to be wished for, and possibly in schools of specialty it may, in some instances, be attained. In the general technical schools, however, where a man is seeking a broad foundation for future scientific or practical work, it seems to us impracticable. Few men can afford to give more than four years to study from that precious period so full of soaring ambitions when a man is beginning his active career; and yet we can not assert too strongly the fact that four years is entirely insufficient for mastering even that

theoretical knowledge so necessary to a comprehensive understanding of the practice. We would advise then the graduate to know himself; to realize more clearly the magnitude of the work he has undertaken; to understand that his college degree does not confer ability, but is merely the first step, the introduction as it were, to his life study proper. Nor must the manufacturer expect too much from his young engineer; let him alone for awhile, let him establish his bearings, and give him an opportunity himself to bring together his theory and the practice. He will do it more quickly and effectually if left to himself than he possibly could if confronted at the outset by problems the rapidity and accuracy of whose solution are to serve as measures of his ability.

LAST month we began a review of Mr. D. R. Steuart's paper on "The Flash Point and Heat of Burning of Mineral Oils," quoting through him the published opinions of Sir Frederick Abel and Mr. Redwood, governmental advisors, and showing the utter unreliability and danger of their report. The remainder of Mr. Steuart's paper is of much interest and deserving of reproduction in full, giving as it does tabular results of an admirable series of experiments. Unfortunately these tables cannot here find space, but we will endeavor to give a synopsis of the results, showing clearly the effect of the flashing point on the heat developed in burning in all the relation of difference in quality, the pressure of the heavy oils, or of chemicals left in the oil, etc. Abel and Redwood, it is remembered, place 73° F. as a maximum flash point, or as a point of perfect safety, and advocate metallic containers for the oil in lamps, acting on the erroneous theory that the lower the flashing point and the higher the temperature to which the oil is raised, the more perfect the expulsion of air from the reservoir, and hence the less the danger of formation of explosive mixtures therein. The conditions of Mr. Steuart's experiments were briefly as follows:

"The same lamp with the glass reservoir was used throughout, being a Young's duplex; the metal lamp was also a duplex, and is believed to be exactly similar to the one which caused Lord Romilly's death; the wicks were replaced for each experiment, thus avoiding error through the cumulative effects of bad oils. The temperatures were taken by immersing the thermometer bulb in a small tube, carrying mercury, soldered to the metal outside the chimney. When a lamp burns badly, it generally develops more heat than usual, the light is red instead of white, and the combustion is imperfect, producing a bad smell. This may arise from a bad lamp, the air supplied not being sufficient or not properly reverberated on the flame, or from the chimney being too short or so badly shaped as to give a back current inside the widened part; or it may arise from the lamp being dirty and air-holes partly filled; or from the wick being bad, damp, or dirty; or from the oil being polluted with a trace of vegetable or animal oil in the dishes used for measuring or filling; or from the oil itself being bad from refining chemicals being retained, or heavy oils being present."

The stopping of air-holes decreased the light in many cases, and in all had the effect of raising the temperature. The flash-point, it is found does not always rise in proportion to the specific gravity, as the oil may either be homogeneous or may consist of a mixture of light and heavy oils, whose average gravity will still be the same. The effect of such a mixture may be seen in the inspections of the tables of experiment, where a light special oil of gravity .782 is mixed with a heavy marine sperm of gravity .830; the light was pretty well kept up (22.2 candle-power after a half-hour's burning and 18.2 candle-power after seven and one-half hours' burning), but the heat developed was much greater than with either oil separately. (In the mixture a mean after 7½ hours of 112° F.; in the special for the same time 102° F., and in the marine sperm 105° F.) Mr. Steuart further shows the influence of a wick of poor quality. "A closely-woven wick fractionates the oil to some extent, and the residue in the wick and lamp tends to get heavier; so that an oil containing

heavy oil with such a wick burns very badly after an hour or two, while a homogeneous oil burns well throughout. With a very good loose wick, the heavy oil rises pretty well, and the burning of badly fractionated oil approximates to the well fractionated." The burning of oils is further modified by treatment with acid and soda after the last distillation, the color and odor both being improved. Sulfo compounds of soda are, however, retained, and unless these are carefully removed the oil suffers in quality. The sulfo-compounds are decomposed in the burning, and the free sulfuric acid formed seriously chars and injures the wick.

Carefully fractionated homogeneous oils are low or high in flash in proportion to their specific gravity and to their boiling point. Oils flashing at 100°, 155°, and 230° F. give practically the same temperature in burning, averaging 103°, but similar oils burned with the air-holes partially filled, "as lamps generally are," gave for the lowest flashing point the highest temperature. It will be remembered that Abel and Redwood obtained opposite results, how, it is not stated. Mr. Steuart's experiments were exhaustive, and in all instances his results were as given above. The paper is concluded by general observations most of which were given in our last review, the general trend being that the higher the flash-point the safer the oil, and that the lowest point that can with any safety be accepted, using the most improved tests, is 100° F.

THERE appeared recently in one of the newspapers a short article of some interest regarding petroleum as a fuel for torpedo boats. Reasons against its general use as a fuel for the navy are clearly given, and then its many obvious advantages for the smaller boats in harbor defense are likewise admirably set forth. "It may not be introduced in all war-ships," because, first, of its greater cost as compared with coal, the difference in price naturally becoming greater accordingly as the demand for the one should increase and the demand for the other decrease. The possible discovery of new fields would be offset by larger demand for petroleum for illuminating and industrial purposes. The use of such fuel would add an additional source of danger from explosion; great care would be necessary in storing to avoid displacement through motion of the vessel; there would be danger of fire from hostile shots, and the machinery would lose its protective casemate of coal. Further, there is the difficulty of obtaining the fuel supply on long cruises, the United States not having foreign possessions. These are in general the arguments against its use, but Engineer Rae, U. S. N., has found by careful investigation that there is no more danger in the use of petroleum than from any other explosive; that by atomizing instead of gasifying the petroleum, complete combustion is secured, and the deposition of solid carbon with consequent choking of the pipes is thus avoided. The source of fuel-supply would not be a question with the torpedo service, and, as the success of burning oil to raise steam is now a fact, the following advantages are summed up. The radius of action would be increased; the fuel could be conveniently stored and would not require trimming; the fuel could be more easily handled, thus reducing the labor; the fires would be under better control; the boilers and boiler-tubes would last longer; while finally, the absence of smoke, flames, and sparks would enable the movements of the vessel to be made with much less risk of detection. In time of war the increased expense would hardly be of moment, being many times outweighed by the greater ease and efficiency of action.

IN the practical application of the electric current through electrolysis for the manufacture of caustic soda and bleach, there is opening to us a new field of chemical technology almost boundless in its reach; hence the following figures, presented by Messrs. Cross and Bevan, may be of general interest, as they certainly will be to American manufacturers. The production from a plant treating 18 tons of salt per 24 hours may be taken at 8.3 gross tons of chlorin, equal to 22.43 gross tons of bleach and 9.38 gross tons of caustic soda, with bleach at £7.10s. per gross ton and

caustic soda £12 per gross ton the total value would be £280.10s. The cost of production would be as follows: power, £60; 18 gross tons of salt, £10.16s.; 12 gross tons lime, £7.4s.; labor, £10; casks, etc., £18; depreciation at 10% per year, £10; costs of renewal, £30; superintendence, £5; total, £151. Placing the interest on the capital at £10, the total expenditure would be £161 against £280 receipts. The cost of the plant would be £50,000. Some of the items are debatable, but the whole may be accepted as a fair estimate, taking exception only to the item of £30 per day for renewal of diaphragms and anodes. In the English process the "electrolozer" is a rectangular tank divided by diaphragms, the latter consisting of V-shaped pieces of slate and glass packed in position by asbestos. The anode is of retort carbon set with type metal, and is claimed to be uninjured by the chlorin set free. In the American process the tanks are of iron with sloping floors; the diaphragms are double and made of parchment paper and asbestos sheets matted together with coagulated albumen. The anodes are of gas retort carbon fastened with lead, and the cathodes are of thick iron gauze. The reaction takes place with a voltage of 2.5, but practice shows 4.5 volts to be more efficient. The yield is described as fully 80% of the theoretical efficiency.

IT is now proposed to utilize the iron cinder from the puddling furnace in the production of red paint. The process is as follows: First a crushing of the cinder (1000 kilos) until it passes a screen of 100 perforations to the square centimeter; to this is added 170 to 200 kilos of 66°B sulfuric acid. The mixture is worked by hand and then in a mechanical mixer until homogeneous, and finally is allowed to "sweat." Chemical reaction takes place, raising the temperature and forming protosulfate of iron, which, being calcined in presence of air, is readily converted to the sesqui-oxid and free sulfurous acid. The "sweating" lasts several days, the calcination, however, being complete in as many hours. The process is certainly feasible and suggestive of possibilities.

A GAS that is non-explosive, non-asphyxiating, non-poisonous, that is remarkably cheap in production, that requires a most simple plant and small outlay, that flows more easily than coal gas or water gas, thus requiring less initial pressure for conveying long distances, is, to say the least, extraordinary and well-nigh incredible; yet this gas is being manufactured in an experimental plant built on a commercial scale and has each of the qualities named above. Moreover it is of high illuminating power and of great thermal value. What more can we ask for? Does it not seem that perfection has been reached? It has been the good fortune of one of our associates to see this plant in operation and to follow the gas from its inception through the most crucial tests, and though we can say nothing further at present, we hope to obtain permission to give more definite particulars to the public in the near future.

THE metallic carbonyls are now the subject of much investigation, particularly with the French chemists, and as their formation is so intimately connected with all the latest theories of metallurgical chemistry,—or the chemistry of high temperature,—their study is one of great interest as well as of practical importance. Berthelot has made a careful study of nickel carbonyl, and has published his results, some of which will be given briefly below. The vapor density of nickel carbonyl at 16°C. is about one-fourth of one atmosphere. If a drop of the liquid be evaporated spontaneously, crystals are formed, which, however, are volatilized on continued exposure. Exposed to the air, the carbonyl readily oxidizes, and also when passed with an inert gas through a strongly heated tube it breaks up into metallic nickel and carbon monoxid (CO). Heating sharply to 70°C. produces the same results. The vapor of nickel carbonyl is nearly insoluble, but is readily soluble in the hydrocarbons, especially spirits of turpentine. Explosion can be produced by violent agitation with oxygen over mercury, by direct ignition, and by contact with strong sulfuric acid. It is unaffected by the caustic alkalies, and

is only acted upon by gaseous ammonia, when the latter carries with it a little oxygen. Hydrogen sulfid and also hydrogen phosphid act readily, the former producing a black deposit of sulfid. The carbonyl can be preserved under water, but in a bottle with ordinary stopper it becomes oxidized, forming the hydrate and giving forth slight fumes of complex oxids, which Berthelot managed to collect and analyze, finding them to correspond to the formula C_8O_8 Ni_8 $10\,H_2\,O$. The carbonyl of iron has also been studied by Berthelot, and he has shown that carbon monoxid passed over "reduced iron" at a temperature of 45°C. takes up considerable iron with it. The gas gives the spectrum, and deposits partially oxidized iron upon a porcelain held in the flame. The probable presence of iron carbonyl in illuminating gas has been noticed by Yuntz. In view of Berthelot's experiments we have no reason to doubt its existence there.

MR. LEAVITT'S experience at the Calumet and Hecla mines in 1874 was that, whereas with steam-pipes laid unprotected and in a trench merely covered with earth, there was much loss through condensation, upon applying a coating of one part of plaster of Paris and two parts of sawdust the condensation was reduced to one per cent. of its former figure. Professor Eggleston of New York mentioned the case of the bridge of Grenoble, where after 211 years iron which had been covered with cement was found as bright and intact as when first placed in position. Mr. Babcock, drawing from these two experiences, proposes to combine the two for underground work; first whitewashing over with Portland cement, then covering with plaster of Paris and sawdust, and finally applying an outside thin coating of cement mortar. This was not deemed suitable, however, for exposed piping, and Mr. Babcock turned his attention to the cotton wadding and like fibrous materials. Speaking of asbestos, he falls into an error from a chemical point of view, saying: "Trace it [asbestos] back, and we find it simply aluminum or clay, but in a different form." This is evidently merely a slip, and we only note it in passing. Professor Ordway's remarks upon the value of asbestos as a heat-resisting medium are well worth repeating, and we quote: "Asbestos is commonly supposed to have a wonderful virtue in resisting heat, but there is really no magic power in the mineral fiber. It is a non-conductor only when it is in a light, downy condition and full of air. It was observed that in those cases in which asbestos paper is put between the pipe and hair felt, the asbestos fails to prevent the scorching of the hair. Incombustibility should not be confounded with non-conducting power. And then again, a wrapping of asbestos paper does not insulate so well as the same thickness of mere air. The popular confidence in asbestos partakes of the character of a superstition." Professor Ordway further shows that the value of a fibrous coating depends largely upon the power which it has of holding the air, confined as it were in interstices.

Considering all these points, Mr. Babcock fastened upon cotton or wool fiber as being the best for non-conducting purposes, and now had only to fix upon a method of giving back that slight increment of heat sure to be lost with the best of protective coatings. With steam this loss is made good from the boiler, but in water pipes at natural temperatures only a rapid circulation can accomplish a like result. This rapid circulation being impossible without great waste and financial loss, it became necessary to supply the heat from without. For this purpose he used the wool waste from the knitting mills, there near at hand, and attained highly successful results. The principle was this, that the waste was more or less saturated with oils, and these by slow combustion in contact with the air—strictly oxidation—gave off just that increment of heat necessary to supply the loss taking place through the covering. It amounts to simply the use of a slow-burning, non-igniting fuel, found to last, in Mr. Babcock's experience, being properly covered with planking, for an approximate period of five years.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

AN important ruling in regard to the rights of shareholders in mining corporations has been made by Judge Hallett, of the United States District Court in Colorado, who holds that any stockholder has a right to enter the mine and examine it to his own satisfaction. The decision was made in connection with a suit against the Mollie Gibson Mining Co. of Aspen, but will serve as a precedent in similar cases. The mine in question has paid $2,800,000 in dividends, the regular monthly rate being $150,000, and is the most successful American silver mine of the day, but its condition underground has been a mystery to the public and all but a very few of the managers, and the men working in the stopes, who have been under a pledge of secrecy.

That this decision is sound in principle and based on a spirit of fairness needs no argument. Whether the permission to enter and examine a mine in which he is interested will be of much use to the average shareholder is another matter; but there are often cases where it would be a great advantage to shareholders not in the control to be allowed to have an expert examination made of the properties in which they own stock. Such a privilege, if acted upon, would have rendered many of the stock-manipulating schemes of the past inoperative.

According to the laws regulating corporations, of whatever kind, in many of the States, shareholders are entitled to examine the books of the companies. The right is however practically a dead letter, for an examination of the books, to amount to anything, would have to be made by an expert accountant and would occupy many days. Still, that the right is legally recognized, and also that the ruling just cited has been made, shows that the tendency of the laws and their exponents is in the right direction.

There are usually two sides to every question, and here there is something to be said on the other side, too. It looks like a hardship for the officers of a mining company to be bothered by an overhauling of their books or visits underground made from idle curiosity, and there would be some difficulty in deciding just what would be a sufficient motive for one or the other, and whether the inconvenience and interference with office routine or mine work would be warranted. Yet as neither law nor authority can determine these delicate points, it is manifestly better to err on the safe side and open the doors as widely as may be to investigation. Particularly must this be true of mining companies which have offered their shares to public subscription and which are listed on the exchanges. Some mining companies, although regularly incorporated with State laws, are really close corporations, in which there are no outsiders, but only a handful of owners who have gone through the form of incorporating for the sake of business convenience, and who do not offer stock to the public or list it. Where such is the situation there is not likely to be disagreement among the owners, and it is nobody else's business how the books are kept or what is the condition of the property, except as to danger of accident. But since it is intended to open the books and the mines to *bona fide* shareholders only, there can be no objection on the part of the companies which do not need watching to the liberal interpretation of the laws.

THE Mesabi iron range seems destined to seriously affect the iron-ore market during the coming shipping season and still more so next year, after preparations for rapid mining and handling of the ore are perfected. Professor H. V. Winchell, who has made a very careful examination of this new Minnesota iron district, reports that there

is ore in sight for many years to come, and that permanent investments and improvements of the most extensive nature can safely be made, based on an expectation of the sufficiency and quality of this ore-supply. Contracts have been made calling for the minimum production of 1,500,000 tons per annum. This is 80 per cent. more than has ever been produced by the Vermilion range in one season, and is about one-sixth of the entire Lake Superior product. The yield of some of the largest mines is not included in this minimum figure. It is moreover likely that some companies will ship more than their minimum amount. The Mesabi ore occurs in flat beds, near the surface, covered by from twenty to ninety feet of glacial drift. The best ore is a soft hematite. Although the range is at a disadvantage in point of freights to the market, the cost of mining is exceptionally low. Where the method of stripping is practicable and no blasting is required, machine excavation is calculated to cost only $11\frac{1}{8}$ cents per ton of ore as a minimum; harder ores, mined by hand, 48 cents as a maximum. Professor Winchell thinks 25 cents a fair average per ton loaded on cars. At this rate the total cost of the ore delivered at Cleveland would be $3.10 per ton, including royalty, railroad freight to the lake, lake freight, insurance, and commission, which would have an ample margin below the ruling price ($4.25 a ton) last year for 60 per cent. Bessemer ore, to allow for any decline brought about by the new competition.

THE close of the year 1892 was marked by two mining excitements, not yet on a large scale. One was the rush to the gold placers on the lower San Juan, near its junction with the Colorado river, the new fields being in southeastern Utah, not far from the Arizona and Colorado lines. The number of men now there is variously estimated at from 2000 to 5000. Conflicting accounts are received as to the value of the deposits. There is certainly much gold in the region, but whether so situated as to warrant placer mining on a large scale remains to be proved. The latest reports from this region are discouraging, and many of the disappointed prospectors who rushed there have returned or are prospecting in the Henry mountains and along the Colorado river. A small flurry was caused by the announcement of the discovery of diamonds in Oroyhee county, Idaho; but it is rather hard to arouse enthusiasm over reported diamond fields in this country, after the exposé of the Arizona diamond swindle, now of historic fame. That there *are* diamonds in various parts of the United States, notably in California and North Carolina, to say nothing of other localities, is well known, and many stones of small to medium value have been found; but nothing hitherto to encourage systematic diamond mining. It is quite likely that there is foundation for the Idaho story, but thus far the accounts are mysteriously muddled.

RECURRING to the question of renaming aluminum (mentioned in the November number of this Magazine), it should be added that the word proposed which apparently has the strongest support is "alium," suggested by Mr. Oberlin Smith and (independently) proposed also by Professor Elihu Thomson. The former gentleman has said:

> It is earnestly to be hoped, if we are ever to have a shorter name than either of the two present ones, that some decided step will soon be taken by the proper authorities, if their existence and identity can be determined, to establish, once for all, a shorter and more convenient name. If the leading technical journals in this country and abroad could be induced to agree upon the word "alium," or something better, if such can be suggested, and if, furthermore, the national engineering societies should see fit to endorse the same, the work of reform would practically be accomplished, as it is not probable that those who are strictly scientists only would hold out against a popular verdict of the kind mentioned.

Meanwhile there is a possibility that the nickname "al" may become current. This brings up some points of a similar nature. Here is another metal in trouble about its English name. Miners and metallurgists call it "quicksilver"; chemists speak of it as "mercury." Why not drop one of the superfluous synonyms? Another: In

the classification of the custom-houses and the Bureau of Statistics there is something called "zinc, spelter, or tutenegue," the verbiage being intended to leave no loophole for any dutiable but evasive metal to crawl in through. We all understand that in the trade usage "spelter" means crude zinc. What "tutenegue" is may puzzle most people. The word is not in the dictionaries, but "tutenag" is, and is defined as "Chinese copper, an alloy of copper, zinc, and nickel," also as "Indian zinc." Former definitions of "steel" are hopelessly obsolete now. To make clear what is meant the generic word has to be qualified by an explanatory term. Thus we speak and read of "open-hearth mild steel," "crucible tool steel," "Hadfield steel," "chrome steel," "nickel steel," and so on through the endless varieties. There is probably no practicable way of simplifying this.

If we turn to mineralogy, the situation is still more confused. Hardly a common mineral but has a string of synonymous names. In this country Dana's "Mineralogy" is followed pretty closely in scientific usage, but where a common term has an old standing and is generally understood, it looks like affectation to substitute the technical one; though convenience and real utility would be gained by adhering to *any* standard, for the perplexing array of synonyms that have to be mastered by the young student is an awkward stumbling-block in his way.

THE following news item is taken *verbatim* from a dispatch from Lampassas, Mexico, in a daily newspaper:

> The famous Iguana mines near this city have again gone into a bonanza, and the owners have a vast fortune of ore now in sight. Bonanza vein lies in an almost horizontal position five miles in width, carrying gold ore to the value of $150 to $200 per ton. The foot walls often are from eight to ten feet in diameter to ten inches in depth, in which the richest of ore is found, running in value from $2000 to $3000 per ton.

This isn't funny at all. It is painfully serious, and might be used as the text for a long diatribe on popular ignorance of mining. It is not merely an illustration of how the reporter, the translator, the telegraph, the telegraph editor, the compositor, or the proof-reader may between them get things mixed, but that it was published in this shape argues that the management of the paper believe that any jumble of nonsense will pass with the public. Now the public, as a matter of fact, is not so ignorant by half as all that; though once in a while you run across some queer notions about mining, which give an excuse and a reason for the kindergarten style so often adopted in descriptions of mining intended for that long-suffering personage, the "general reader." For instance, the writer was once asked by a New Yorker, a business man of common sense and by no means uninformed as to most matters of common observation, "How wide are gold veins, anyhow?" It was explained that they ranged all the way from a knife-edge to hundreds of feet in width, but that miners preferred to have them about the width of an ordinary drift, say four or five feet across, or less, for convenience in working, other things being equal. "Great Scott," he exclaimed; "but I'd like to get at a vein as big as that for just one day!" Since then nobody else has been met who thinks that a "gold vein" is literally a *gold* vein, that is, of solid native metal; but several people have turned up who suppose that shafts are sunk and adits run to enable the miners to go and find nuggets, which are then shoveled into buckets and sent to the mint.

AS a safeguard against coal dust explosions in mines the present Mines Regulation Act of Great Britain contains a rule prescribing that all dry and dusty places shall be well watered within a radius of 20 yards of where a shot is to be fired. The *Practical Engineer* remarks that, although this is a step in the right direction, still in the opinion of those best qualified to judge it is quite inadequate; and adds that it is to be feared that this rule is as often honored in the breach as in the observance. The only reliable safeguard against the danger arising from the presence of coal dust is, according to Mr. Arthur Laurie, to moisten the air throughout its passage

through the workings. This it appears is being done in some pits in South Wales at present. The water is conducted along the workings in pipes laid from the surface, and a tiny pinhole pricked in the pipe creates a fine spray, which is carried along by the current of air, and suffices to lay the dust for a hundred yards or so, when another pinhole takes up the running. This remedy, it will be seen, is a simple one, though the amount of water which would pass through "pinholes" at such distances would hardly be enough to be very efficient. However, this is easily adjusted. The *Practical Engineer* thinks that it is not asking too much that in very dusty mines the precaution now adopted by the careful and considerate few should be made compulsory upon all, and advocates an extension of the law in order that the present rule may be made to embrace this precaution. Much less attention has been given in this country than in England and Germany to the effect of coal dust in originating or aggravating mine explosions. Few accidents have occurred in American mines in which dust is believed to have played a part, and there are relatively not many dusty mines. It does not at present seem necessary to enact laws to cover exceptional cases. But the simple watering (or rather dampening) device just described is worth making a note of for trial where such precaution is needed.

The explosion at the King colliery, near Como, Colorado, on January 10, by which twenty-four miners were killed, was however due to ignition of coal dust by a blow-out shot, the dust having been raised by the feet of the men and by previous blasts. The mine, though gaseous, was well ventilated and it is thought to have been free from standing gas.

ASPHALTUM and bituminous rock are mined in California, Utah, Kentucky, and Ohio. The production in this country is not yet large,—amounting to some 50,000 tons annually,—though with the present demand for asphaltum for street paving it seems strange that the known deposits have not been more energetically worked. From a mine at La Patera, in southern California, there was recently taken a solid block of asphaltum weighing two-and-a-half tons, said to be the largest block ever mined in one mass. Besides asphaltum proper, there are a series of bitumens known as gilsonite, uintite, elaterite, Wurtzite, albertite, grahamite, etc., of which Utah possesses important deposits. Some of these varieties possess value as varnishes and insulators and for other purposes, and they are being utilized to a small extent. Trinidad asphaltum is largely imported for asphalt-concrete paving, and commands the market in the Eastern States by reason of cheaper transportation as compared with the material from the Western sources. Consul Pierce makes the following estimate of the cost of Trinidad land pitch: Price of asphalt in the ground, $4 per ton; digging, cleaning, and superintendence, 50 cents; carting, lighterage, loading, contractor's profit, commissions, etc., $2.30; export duty, $1.20; freight and insurance to New York, $2.25; total, $10.25 per ton. When large quantities are being handled or under better circumstances, the price could be reduced. It is a matter of record that the first cost of taking asphalt from the pitch lake is only 40 cents a ton. It can be dug more easily than the land asphalt.

A FIELD-GEOLOGIST can make his observations and reduce them to maps at an average rate of about 100 square miles a year, when all waste of time in mensuration and the location of points is spared him by previous detailed topographic surveys, as for example in England and in parts of this country. Such a rate might indeed be considered unnecessarily slow for large areas of the simpler type in the United States. For geological work in complicated mountainous regions (where most of the important mining districts are), if the survey should be for the sake of constructing not merely such maps as would satisfy the requirements of general geology, but such as would be detailed enough and precise enough to be of much real use to the miner in underground prospecting, an average annual rate of 100 square miles would be entirely too high for thoroughness. A full

year's field work is seldom at command, as the surface may be hidden by snow during a large part of the time, thus reducing the working season by one-half or more. There are some mineral areas of less than 10x10 miles square which have been, not merely surveyed by one expert in one year, but gone over and over by different geologists in succession, with abundance of time and means at their disposal, where the miner is still left very much in the dark as to the particular points in which he is directly interested. This does not imply discredit of the value or reliability of geological examinations; but rather indicates that mining districts, in the nature of things, offer a more intricate and difficult field for study than the generality of country. The underground workings often, instead of clearing up problems presented at the surface, bring in new ones; while the geologist, not resting with the study of structural relations, is led into various side issues of physics and chemistry in their relation to the origin of ore deposits.

SOME curious results appear to have been obtained by Professor W. Spring, of Liège, in experiments upon alloys formed by compression of the constituents at ordinary temperature, instead of by fusion. At a meeting of the Amsterdam Royal Academy of Science specimens of brass produced in this way were exhibited, composed of varying proportions of copper and zinc. These specimens are described as not being absolutely compact, having distinct angular fragments of red copper and fragments and threads of zinc, but also containing much yellow alloy in an amorphous state showing a uniform, finely granular appearance wholly different from the crystalline structure characteristic of copper-zinc alloys obtained by fusion. There is much that gives evidence of a flow in the yellow alloy and the zinc, but nothing pointing to a truly liquid state of the alloy or one of its components. The *Scientific American*, in commenting upon these experiments, intimates a belief that "a more complete union of metallic powers by compression will lead to alloys of most remarkable properties, and may give some alloys that cannot be produced by fusion." But whether or not alloys of practical utility can be thus formed, there is a possibility that investigation pursued on these lines may throw some light upon the laws (for such there must be) underlying the formation of alloys at large, about which so much mystery remains to be cleared away.

A MACHINE is being introduced which is designed to take care of the debris from placer mines, and is said to be capable of handling 10,000 cubic yards of gravel daily. It screens out the cobbles and treats the sand, etc., which subsequently can be conveyed by cars or wire rope-way and dumped at a convenient place. The water can be saved and pumped back if required. Like other machines of the kind, this—with its accessory transportation devices for disposing of the tailings—requires that the material treated should not be of too low grade.

THE bullion product of Colorado, as reported by the *Mining Industry*, has been as follows during the past two years:

	1891.	1892.
Silver, ounces	23,102,355	26,669,127
Gold, ounces	217,652	228,254
Lead, tons	63,128	61,593
Copper, pounds	5,537,001	4,667,220

While there has been a considerable increase in the silver output, the market value for 1892 was but little more than for 1891. The total values of the four metals were:

	1891.	1892.
Silver	$22,836,677	$23,148,802
Gold	4,498,866	4,718,010
Lead	5,473,197	4,989,033
Copper	747,495	513,394
Undivided	75,890	.....
Total	$33,632,125	$33,369,239

These values have been computed on the basis of the following average prices. The prices at which the value of the metals was estimated was as follows, being the average for each year:

	1891.	1892.
Silver, per ounce	$ .9885	$ .868
Lead, per ton	86.70	81.00
Copper, per pound	.135	.11
Gold, per ounce	20.67	20.67

COMMENT & CRITICISM.

Labor Strikes and the Law.

IN the November issue of this Magazine I find under "Comment and Criticism" a note on "The Causes of the Homestead Troubles," which seems only to deepen the gloom which a sensation-cultivating press has managed to throw around that most sad and disgraceful exhibition of the workings of trade-unionism. There is no necessity for speculation on the subject. The causes are patent to any one who wishes to see them. They are the certainty that a mob can damage an adversary very seriously before the law will interpose to protect him, and that even then the mob will receive no punishment for its misdeeds. Law is a power for good just so far as it is certain to be enforced, but no farther. Some seem to think that it is only necessary to enact a law and the work is done. Laws do not enforce themselves. When it is certain that a mob, at least its instigators and leaders, will be promptly punished for their crimes, "Homesteads" will cease to occur, not before. That the press and soft-hearted and thoughtless talkers and writers have done much to aggravate the evil is certain. The senseless prating about the sins of capital and the wrongs of the patient, suffering, and unresisting laborers have, no one can doubt, done something toward producing these results. This line of argument at last leads its apostles to put forth as the last and highest revelation the sublimely nonsensical doctrine that the employé has a quasi interest in an establishment in which he has worked and an inalienable right to be employed there. Then we are treated to impressive accounts of the ability, accomplishments, and skill of these laborers, and are gravely assured that the works cannot be run by any other force. Why should not these men think they had a cause, and that the public was quite ready to sustain them?

One point seems to me worthy of note, and I have seen no allusion to it. How did these men acquire their skill, how develop their talents? At their own expense, through years of toil? No. They did this at their employer's expense, and in time that he paid for.

Let it be understood that the law protects every one in working for whom he pleases and at what wages he agrees to work for, and that every one who attempts to prevent him from so doing will be promptly punished; that rioters will be summarily dealt with; that, while men may refuse to work, they must not molest or prevent others from working; in short, that our laws are executed for the good of society and not with regard to the possible effect on someone's chances of reëlection; and we shall have no repetitions of Homestead or Buffalo. I would say I am not rich, own no stock in any corporation and little if any property, and work for my living.

N. A. C.

Utica, Ill., December 22, 1892.

Irrigation and the Mississippi.

THE following passage from the report of the Director of the United States Geological Survey, for 1889, relative to irrigation in the arid regions of the West, may throw some light upon the Mississippi problem which is being discussed in the pages of THE ENGINEERING MAGAZINE:

"The development of irrigation along the base of the Rocky Mountains is of double importance, because of its influence on the agriculture of the lower Mississippi. To store up the water of the Missouri and its main affluents for the purpose of irrigation is to diminish the volume of that flood of the lower Mississippi which is most destructive by reason of its occurring in the heart of the farming season. Moreover, the great difficulty of the problem of the lower Mississippi arises from the fact that the river normally makes a deposit there

thus clogging its course and giving to its channel an unstable position. The principal source of the sediment is the Missouri river, and it is carried forward chiefly during floods. With abolition of the great Missouri floods the sedimentary load of the lower Mississippi would be diminished, and the scouring power of the less-loaded floods from the Ohio and the upper Mississippi would establish for the lower Mississippi a lower grade and a deeper channel. For every acre reclaimed to agriculture in Montana another acre will be reclaimed in Louisiana; and, in general, all lands redeemed by irrigation on the Great Plains will be equaled by the lands redeemed from floods in the great valley of the lower Mississippi." E. S. C.

St. John's, Mich., January 2, 1893.

Long-Distance Power Transmission.

MENTION having been made in THE ENGINEERING MAGAZINE a few months ago of the successful transmission of power by electricity over a distance of ten miles, there has been forwarded to this office some account of the San Antonio plant, in the lower part of California, from which it appears that a portion of the power is to be conveyed thirteen miles and the remainder twenty-three miles. The note follows:

"The most important electric-power transmission-plant yet undertaken in this country is that now in course of construction for the San Antonio Electric Light and Power Co., in Southern California. The power-plant is located in San Antonio cañon, where there is a minimum flow of 1300 cubic feet of water per minute under a head of about 400 feet. The water is brought to the power-station through 1900 feet of 30-inch double-riveted sheet-iron pipe and 600 feet of 24-inch. This length of pipe involves a loss of head by friction of 12 feet, leaving 390 feet effective head or running pressure. The laying of the pipe-line involved a rock tunnel 1300 feet in length as well as several heavy open cuts. The power-station is provided with four double-nozzle Pelton wheels 34¼ inches in diameter, coupled direct to the armature shafts of as many alternating-current generators of 200 horse-power each. Two exciters are provided which are run by Pelton wheels coupled to the shafts in the same manner—requiring 20 horse-power each. By means of transformers the potential will be raised to 10,000 volts and the current at this pressure will be conveyed over bare hard-drawn copper wires to Pomona, a distance of thirteen miles, and to San Bernardino, a distance of twenty-three miles, and is to be used for both light and power purposes. This work is attracting much attention on account of the length of the circuit—it being a longer distance than heretofore attempted in this country. There is, however, no reason to doubt its entire success."

A Correction.

IN describing recent improvements in the No. 3 Brainard Milling Machine in the last issue of THE ENGINEERING MAGAZINE, it was inadvertently stated that Messrs. Hill, Clarke & Co. were the manufacturers. It should have been said that the machine is manufactured exclusively by the Brainard Milling Machine Co., of Hyde Park, Mass., and that Messrs. Hill, Clarke & Co., of Boston and Chicago, are the selling-agents for the manufacturers. This is one of the most widely celebrated machine-tools manufactured in the United States, and as the Brainard company have been making it for twenty-six years past, during which time they have frequently and very greatly improved the effectiveness of its work, they justly feel that the above statement requires a prompt and proper correction.—THE EDITOR.

CURRENT TECHNICAL LITERATURE.

AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE ESTABLISHED TECHNICAL JOURNALS OF THE UNITED STATES, ENGLAND, AND FRANCE.

This publication has been aptly described as "the most conspicuous time-saving device of the modern technical world," and as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the business man, and the student.

The immense volume which technical literature has attained in the last decade, and the rapid rate at which it is increasing, make an index simply indispensable. The man whose time is valuable must have some means of sifting the grain from the chaff—some system by which he can keep in touch with development of every kind, yet select to read only that which concerns his special interest. This index accomplishes that aim to a nicety. It covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that only a few minutes' time each month are required for an active man to learn of everything that has been published concerning his business. In short, it is to the practical man what Poole's celebrated index to periodicals has long been to the literary worker, but with this important difference,—namely, that, in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.*

The unparalleled convenience and economy of this double service are, therefore, the basis of the enthusiastic commendation which has been bestowed upon it. Indeed its value can scarcely be overestimated. To the engineer in the field, to the architect in the interior, to the electrician everywhere—and especially to the foreigner—it offers all the advantages of the most complete metropolitan library; and once used, it is always accounted an indispensable aid to the thorough investigation of any branch of applied science.

In ordering articles from us, care should be taken to give the *number*, not the title alone. The price of a single article is 15 cents, with the exception of the ones indicated by an asterisk (*) or a dagger, (†), the prices of which are 30 and 45 cents respectively, according to the price of the publication quoted, *For prices of serials, see the index itself.*

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In the body of the index the initials of the papers quoted are given, and these can be readily identified by the alphabetical list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.

LIST OF PERIODICALS REGULARLY INDEXED.

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An....American Analyst. *f.* $1 per year. N. Y.
A Ar.....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B M...Architect, Builder, and Manufacturer. *m.* $1.50. Kansas City, Mo.
A C J....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D.....American Druggist. *m.* $1.50. New York.
A E .....Architectural Era. *m.* $3. N. Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Journal of Railway Appliances. *m.* $2 per year. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50.
B I S.....Bulletin of American Iron and Steel Association. *w.* $4. Phila.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1 per year. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A..Canadian Architect. *m.* $2. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C B T....Builder and Trader. *w.* $2. Chicago.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N....Canadian Electrical News. *m.* $1 per year. Toronto.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4 per year. N. Y.
Cos.....Cosmopolitan. *m.* $3 per year. New York.
D E.....Domestic Engineering. *m.* $1. Chicago.
D J.....Drainage Journal. *m.* $1. Indianapolis.
D Jour..Druggists' Journal. *m.* $1. Chicago.
E A.....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ..Engineering Magazine. *m.* $3. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E N.....Engineering News. *w.* $5 per year. N. Y.
Eng .....Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. N. Y.
E P D....Electrical Progress and Development. $2. Boston.
E R.....Engineering Record. *w.* $5. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E W.....Electrical World. *w.* $3 per year. N. Y.
F .....Forum. *m.* $5 per year. New York.
F M.....Farm Machinery. *m.* $1. St. Louis.
F W .....Fire and Water. *w.* $3 per year. N. Y.
G & F....Garden and Forest. *w.* $4 per year. N.Y.
G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R.....Good Roads. *m.* $2 per year. N. Y.
I A.....Inland Architect. *m.* $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. N. Y.
I R W...India Rubber World. *m.* $3 per year. N. Y.
I S F.....Industry. *m.* $2 per year. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A .. ..Journal of Architecture. *m.* $2. Phila.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.
J A E S..Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.
J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I..Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W..Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
J P E.....Journal of Political Economy. *q.* $3. Chicago.
J U S A..Journal of the United States Artillery. *q.* $2.50. Fort Monroe, Va.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L F M...Locomotive Firemen's Magazine. *m.* $1. Terre Haute, Ind.
L M.....Leather Manufacturer. *m.* $3. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P.....Louisiana Planter. *w.* $3. New Orleans.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
M G.....Manufacturer's Gazette. *w.* $2.50. Boston.
Min.....Minerals. *m.* $1 per year. N. Y.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M S P....Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R....Mining and Scientific Review. *w.* $2 per year. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N B D. .Northwestern Builder and Decorator. *m.* $2. Minneapolis.
N C B...National Car Builder. *m.* $2. N. Y.
N M. ...Northwestern Mechanic. *m.* $1. Minneapolis.
N W.....Northwestern Architect. *m.* $3. Minneapolis.
O M.....Overland Monthly. *m.* $3 per year. San Francisco.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P.....Paving and Municipal Engineering. *m.* $1 per year. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P D. ...Painting and Decorating. *m.* $1. Phila.
P E. .....Practical Electricity. *f.* $2 per year. Boston.
P E C P..Proceedings of the Engineers' Club. *q.* $2. Phila.
P Era...Pharmaceutical Era. *s-m.* $2. Detroit.
P L.....Pacific Lumberman, Contractor, and Electrician. *w.* $3. San Francisco.
P M. ..Paper Mill. *w.* $3. N. Y.
P R.....Pharmaceutical Record. *s-m.* $1.50. N. Y.
P S.....Power-Steam. *m.* $1 per year. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
P S N...Popular Science News. *m.* $1. Boston.
R A.....Railway Age. *w.* $4 per year. Chicago
R A E J..Railroad and Engineering Journal. *m.* $3 per year. New York.
R C J....Railroad Car Journal. *m.* $1 per year. N.Y.
R G .....Railroad Gazette. *w.* $4.20 per year. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M..Railway Master Mechanic. *m.* $1. Chicago.
R P.....Registered Pharmacist. *w.* $1. Chicago.
R R.....Railway Review. *w.* $4 per year. Chicago.
R S P....Rudder, Sail and Paddle. *m.* $2. N. Y.
R T .....Rose Technic. *m.* $1. Terre Haute, Ind.
R & T...Roofer and Tinner. *m.* $1 per year. N. Y.
S.....Stone. *m.* $2 per year. Indianapolis, Ind.
S A.....Southern Architect. *m.* $1. Atlanta.
San.....Sanitarian. *m.* $4 per year. Brooklyn.
Sc.....Science. *w.* $3.50 per year. New York.
Sc A.....Scientific American. *w.* $3. N. Y.
Sc A S ..Scientific American Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. N. Y.
S E.....Stationary Engineer. *w.* $2. Chicago.

Sea.....Seaboard. *w.* $2 per year. N. Y.
S Ec.....Social Economist. *m.* $2. New York.
S Era...Sanitary Era. *m.* $1 per year. N. Y.
S J E....Sibley Journal of Engineering. *m.* $2. Ithaca, N. Y.
S M.....Scientific Machinist. *m.* $1.50. Cleveland, O.
S M Q...School of Mines Quarterly. $2. N. Y.
So L.....Southern Lumberman. *s-m.* $2. Nashville, Tenn.
S P.....Sanitary Plumber. *s-m.* $1. N. Y.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R N....Street Railway News. *w.* $3. N. Y.
S R R....Street Railway Review. *m.* $1. Chicago.
S V.....Safety Valve. *m.* $1 per year. N. Y.
T.....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Transactions American Institute of Electrical Engineers. *m.* $5 per year. N. Y.
T C E....Transactions American Society of Civil Engineers. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
W E.....Western Electrician. *w.* $3. Chicago.

THE FOREIGN PRESS.

A M S...Australian Mining Standard. *w.* 30*s.* per year, postpaid, Sydney, Australia.
C G.....Colliery Guardian. *w.* 27*s.* 6*d.* per year, post-paid. London.
C R.....Contemporary Review. *m.* $4.50 per year, New York. London.
C T J....Chemical Trade Journal. *w.* 12*s.* 6*d.* per year, post-paid. Manchester, Eng.
D. .....Discovery. *w.* 8*s.* 8*d.*, post-paid. London.
E.....Engineering. *w.* 36*s.*, post-paid. London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* per year, post-paid. London.
E G.....Engineers' Gazette. *m.* 4*s.*, post-paid. London.
E L.....Electricity. *w.* 6*s.* 6*d.*, post-paid. London.
El.. .....Electrician. *w.* 24*s.* post-paid. London.
Elec.....Electricité. *w.* 15 *fr.* post-paid. Paris.
El P.....Electricien. *w.* 25 *fr.* post-paid. Paris.
Eng L...Engineer. *w.* 36*s.*, post-paid. London.
E P.....Electrical Plant. *m.* 6*s.* per year, post-paid. London.
E R L....Electrical Review. *w.* 21*s.* 8*d.* per year, post-paid. London.
F R.....Fortnightly Review. *m.* $4.50 per year. New York. London.
G C.....Génie Civil. *w.* 45 *fr.*, post-paid. Paris.
G E M...Gas Engineers' Magazine. *m.* 6*s.* 6*d.* per year, post-paid. Birmingham, Eng.
G W.....Gas World. *w.* 13*s.*, post-paid. London.
I.....Iron. *w.* 30*s.* per year, post-paid. London.
I & S.....Iron and Steel Trades' Journal. *w.* 25*s.*, post-paid. London.
I C B.....Illustrated Carpenter and Builder. *w.* 8*s.* 8*d.* per year, post-paid. London.
I C T.... Iron and Coal Trades' Review. *w.* 30*s.* 4*d.*, post-paid. London.
I E.....Indian Engineering. *w.* Rs. 18 per year, postage extra. Calcutta.
I Eng....Indian Engineer. *w.* Rs. 15 per year, postage extra. Calcutta.
I L.....Industries. *w.* 32*s.*, post-paid. London.
Inv. ....Invention. *w.* 28*s.*, post-paid. London.
J G L....Journal of Gas Lighting. London.
J S A....Journal of the Society of Arts. *w.* London.
K.....Knowledge. *m.* 6*s.*, post-paid. London.
M.....Machinery. *m.* 9*s.*, post-paid. London.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* per year, post-paid. London.
M E & E J.Manufacturers' Engineering and Export Journal. *m.* London.
M I.....Moniteur Industriel. *s-w.* 40 *fr.* per year, post-paid. Paris.
M W.....Mechanical World. *w.* 8*s.* 8*d.* per year, post-paid. London.
N..... Nature. *w.* $7, post-paid. London.
N C.....Nineteenth Century. *m.* $4.50 per year. New York. London.
P Eng...Practical Engineer. *w.* 10*s.* per year, post-paid. London.
Pl D .....Plumber and Decorator. *m.* 6*s.* 6*d.*, post-paid. London.
Rev R...Review of Reviews. *m.* $2.50. New York. London.
R N.....Railway News. London.
R U M...Revue Universelle des Mines. *m.* 40 *fr.* per year, post-paid. Paris.
R W.....Railway World. *m.* 83, post-paid, London.
S L.....Steamship. *m.* Leith, Scotland.
S R.....Sanitary Record. *m.* London.
W R.....Westminster Review. *m.* $4.50 per year. N. Y. London.

ARCHITECTURE.

*8812. Fire Losses in Fire-Proof Buildings. Ill. Charles H. Bebb (E Mag–Feb.) 3000 w.

8849. The Fine Arts in Relation to the Sanitary Condition of Our Great Cities. Abstract of lecture by Wyke Bayliss (A & B–Dec. 17.) 800 w.

*8869. The Functions of Truth in Art. A. T. Taylor (Can A–Dec.) 2500 w.

†8882. American Domestic Architecture Through French Eyes (I A–Dec.) 1700 w.

8885. Artistic Property in Europe, Particularly in Regard to Architecture. Alfredo Melani (A A–Dec. 17.) 3000 w.

*8989. Suggestions for Designs from Foliage. —The Spanish Chestnut. Ill. (Pl D–Dec. 1.) 1000 w.

9007. Modern Gutter Hanging for Architects, Builders and Roofers (A B M–Dec.) 700 w.

9060. Historic St. John's Chapel Must Give Way to a New Edifice. Ill. (A & B–Dec. 24.) 600 w.

9069. Abstract of the Presidential Address of McVicar Anderson (A A–Dec. 24.) 2000 w.

*9070. Decoration of Buildings. Ill. Louis H. Gibson (S–Dec.) 1600 w.

*9071. Remarks on Prevalent Methods of Testing Building Stones. Geo. P. Merrill (S–Dec.) 1500 w.

*9078. A French Exhibit of Historic Sculpture. Ill. Chas. M. Kurtz (Ch–Jan.) 3300 w.

9129. New York Building Stones (Sc A S–Dec. 31.) 2000 w.

†9138. The Great Wall of China. Ill. Romyn Hitchcock, and A Winter Ride to the Great Wall of China. Ill. U. B. Dennys (C M–Jan.) 6500 w.

*9140. Recent Brickwork in Boston. Ill. "Puritan" (B B–Oct.) 1500 w.

*9141. Recent Brickwork in New York. Ill. John Beverly Robinson (B B–Oct.) 1200 w.

9168. Notes on the Weight of Crowds (A & B–Dec. 31.) 1500 w.

9184. Dead Nations and Living Art. Ill. Geo. C. Gardner (A A–Dec. 31.) 2500 w.

*9185. The Imperial Institute, London (N W–Dec.) 1000 w.

*9304. The Proposed New French Hospital in San Francisco. Ill. (C A–Dec.) 1500 w.

*9305. Stair Table (C A–Dec.) 100 w.

9330. Modern Steel Frame Construction. Ill. (C & B–Jan.) 800 w.

9331. Combination Lead and Felt Roofs (C & B–Jan.) 350 w.

9372. The Potsdam Red Sandstone Quarries. Ill. (Sc A–Jan. 7.) 2000 w.

9393. Preserving Tin Roofs (Met W–Jan. 7.) 2600 w.

9418. Wind Pressure on Roofs. Ill. Ward Baldwin (E R–Jan. 7.) 450 w.

9422. A Distinction in the Acoustic Purposes of Public Buildings. H. C. Kent (A A–Jan. 7.) 8500 w.

*9423. Architects vs. Plan Factories. Arthur Seymour Jennings (N B D–Dec.) 800 w.

*9445. The Art of Decorative Composition. Ill. (A E–Dec.) 400 w.

9467. Rapid Building in America (A S–Jan. 7.) 400 w.

9563. Modern Mosaic. Alvan C. Nye (A A–Jan. 14.) 2700 w.

9564. The Evolution of the Modern Fireplace. Will Walter Jackson (A A–Jan. 14.) 800 w.

9575. "Pecksniffianism," Æstheticism and Clients. G. B. Bulmer (A & B–Jan. 14.) 2000 w.

9585. Chimney Construction and the Building Laws (E R–Jan. 14.) 1100 w.

*9648. Charpente Metallique pour Ateliers de Construction. Ill. F. Desquiens (G C–Dec. 24.) 4000 w.

Serials.

2285. Construction. Ill. M. Viollet-le-Duc (A A–Began Feb. 20—18 parts to date—15 cts. each).

5676. Circle on Circle. Ill. D. E. Scribe (Met W–Began Aug. 6—13 parts to date—15 cts. each).

6415. Bucrania. Ill. (A A–Began Sept. 3—4 parts to date—15 cts. each).

7121. Office Help for Architects. Ill. George Hill (A A–Began Oct. 8—5 parts to date—15 cts. each).

8220. Bricks and Joints in Brickwork (B B–Began Sept.—Ended Oct.—2 parts—30 cts. each).

8503. The Champagne School of Architecture. Ill. P. Planet (A A–Began Dec. 3—3 parts to date—15 cts. each).

8629. Les Constructions Coloniales. Ill. Bernard et Labussière (G C–Began Nov. 12—3 parts to date—30 cts. each).

8703. Blunders of Fire-proofing. T. R. Tinsley (F W—Began Dec. 10—5 parts to date—15 cts. each).

8881. Japanese Architecture at Chicago. Ill. P. B. Wight (I A—Began Dec.—1 part to date—45 cts).

8903. Impressions of a Decorator in Rome. Ill. Frederic Crowninshield (Sc M—Began Jan.—1 part to date—30 cts).

9430. Daylight in the Dwelling-House. John Brett (A & B—Began Jan. 7—Ended Jan. 14—2 parts—15 cts. each).

9508. Ideality in Architecture (J A—Began Dec.—1 part to date—30 cts).

CIVIL ENGINEERING.

*8813. The Great Wall of China. John A. Church (E Mag–Feb.) 3000 w.

8822. The New Concrete Masonry Dam of the Butte City Water Co. Ill. (E N—Dec. 15.) 1600 w.

8824. The Consulting Engineer's Report on the Nicaragua Canal (E N—Dec. 15.) 2000 w.

8825. Masonry Sea-Wall. Ill. (E N—Dec. 15.) 700 w.

8828. The Nicaragua Canal Status. Editorial (E N—Dec. 15.) 2500 w.

8864. A Civil Engineer's Observations on Street Paving and Street Railway Tracks in Several Cities (P–Dec.) 2000 w.

8865. What An Iowa Engineer Says About Brick Street Pavements (P–Dec.) 1500 w.

8866. The Great Movement for Better Roads. A. A. Pope (P–Dec.) 1000 w.

8887. From Jersey to Brooklyn. Ill. (F W–Dec. 17.) 400 w.

*8927. The Deformations of Metallic Bridges (C G–Dec. 9.) 1000 w.

*8981. Cardiff Dock Schemes.—The Proposed New Bute Dock. Ill. (Eng L–Dec. 9.) 3000 w.

*9000. An Engineering Feat (G E M–Dec. 10.) 1500 w.

†9005. The Solani Aqueduct, Ganges Canal. Ill. (I E–Nov. 19.) 350 w.

9026. The Effect of Cushioning Cement Grips. Ill. (E N–Dec. 22.) 700 w.

9027. Masonry Dam of the Butte City Water Co. Ill. (E N–Dec. 22.) 60 w.

9029. The Movement for Better Roads (E N–Dec. 22.) 900 w.

9030. A Highway Bridge Failure Near Frankfort-on-the-Main, Germany. Ill. (E N–Dec. 22.) 300 w.

9037. A Low-Level-Approach, High-Level Bridge. Ill. (E N–Dec. 22.) 250 w.

9083. Assessments for Street Work (E R–Dec. 24.) 900 w.

9093. Street Paving. Chas. T. Davis (C B T—Dec. 24.) 1300 w.

9126. Improvements at the Harlem River Bridge. Ill. (Sc A–Dec. 31.) 1200 w.

9133. The Eidograph. Ill. (C–Jan.) 1500 w.

*9195. The Cannich Bridge Collapse. Major Marintius' Report (I L–Dec. 16.) 700 w.

*9216. Cedar Block Paving. Thos. Appleton (J A E S–Nov.) 3000 w.

9222. Prof. S. Waterhouse's Address before the New Orleans Nicaragua Canal Convention. (A S–Dec. 31.) 3000 w.

†9235. Bridge over the Thaibyn Choung,

Kyaik-to-Belin Road, Shwegyin District, Burmah. Ill. (I E–Nov. 26.) 400 w.

*9295. The Tower Bridge (I & S–Dec. 24.) 1200 w.

9333. A New Thames Tunnel. Ill. (Sc A S–Jan. 7.) 850 w.

†9384. Thin Floors for Bridges, with Discussion. Ill. Albert F. Robinson (T C E–Nov.) 9000 w.

†9386. Electric Rock Blasting.—The American Method. Ill. Wm. L. Saunders (T C E–Nov.) 13,000 w.

†9387. Construction of a Cheap Dam Across the Roanoke River, Near Salem, Va. Ill. Oscar Saabye (T C E–Nov.) 1700 w.

9395. The Pecos Viaduct. Ill. (E N–Jan. 5.) 2600 w.

9397. Dike Construction on the Yellow River, China. Ill. (E N–Jan. 5.) 300 w.

9400. Investigation as to the Effect of Retempering Upon the Strength of Cement Mortars. Ill. L. H. Goddard and P. P. Evans. (Took first premium of the Engineering News Publishing Co.) (E N–Jan. 5.) 1500 w.

9446. The Terre Haute Bridge Failure. Quinton McNab. (R R–Jan. 7.) 1100 w.

9450. Combination Bridge Building on the Pacific Coast. Ill. (R R–Jan. 7.) 1500 w.

*9468. Bonar Bridge over the Kyle of Sutherland. Ill. (I L–Dec. 30.) 1400 w.

9520. Paving Brick; Differences of Quality. D. V. Purington (P–Jan.) 1000 w.

9521. French and American Asphalt Pavements Compared. Louis H. Gibson (P–Jan.) 1400 w.

9522. Old Towns and New Streets. J. W. See (P–Jan.) 900 w.

9523. Maintenance of Roads in France. Arthur Lagron (P–Jan.) 500 w.

9524. Specifications for Brick Pavements in Detroit (P–Jan.) 3500 w.

9527. Proposed Elevated Sidewalks. Ill. (Sc A S–Jan. 14.) 450 w.

9548. The Expansion and Contraction of Ice. Editorial (E N–Jan. 12.) 1300 w.

9549. Movement of Bridge Piers by Expanding and Contracting Ice. Ill. (E N–Jan. 12.) 2000 w.

9565. The 155th Street Viaduct and the Seventh Avenue Drawbridge, New York City. Ill. W. G. Triest (R G–Jan. 13.) 1800 w.

9566. Effect of the Deep Water Channel on the Lake Levels. George Y. Wisner (R G–Jan. 13.) 900 w.

9571. The United States and the Nicaragua Canal. Ill. (R G–Jan. 13.) 4000 w.

9584. Governor Flower on Highways (E R–Jan. 14.) 1000 w.

*9601. Recherches Expérimentales sur la Déformation des Ponts Métalliques. M. Rabot (M I–Dec. 6.) 1400 w.

*9636. Drague a Prémie pour les Indes, Système W. Simons et Cie. Ill. F. Delannoy (G C–Dec. 3.) 550 w.

*9645. Etude de Quelques Projets d'un Pont Mobile sur le Canal de Duluth. Ill. P. Crépy (G C–Dec. 17.) 1800 w.

*9652. Pompe à Sable et Drague à Trémie "Columbus." Ill. F. Delannoy (G C–Dec. 24.) 500 w.

ELECTRICAL MISCELLANY.

*8814. Practical Farming by Electricity. Ill. A. F. McKissick (E Mag–Feb.) 3000 w.

8829. Some Defects of Electric Traveling Cranes (E N–Dec. 15.) 1200 w.

8838. The Bruckner Electrical Engraving Machine. Ill. (W E–Dec. 17.) 700 w.

8839. Indications of the Shifting of Neutral Points. C. O. Poole (W E–Dec. 17.) 800 w.

*8862. Regulation Test of the Ryan Special Series Motor. W. L. Bliss (S J E–Dec.) 900 w.

*8904. Experiments in Electric and Magnetic Fields, Constant and Varying. Ill. E. C. Rimington and Wythe Smith (El–Dec. 9.) 1000 w.

8911. Charging Storage Cells (S E–Dec. 17.) 1600 w.

8912. Some Electrical Thoughts. R. James Abernathey (M N–Dec. 15.) 1000 w.

*8938. Notes Upon the Use of the D'Arsonval Galvanometer on Shipboard. H. W. Sullivan (E R L–Dec. 9.) 900 w.

*8940. Electrical Standards (N–Dec. 8.) 900 w.

8944. Non-Polarized Ammeters. Clarence E. Gifford (E W–Dec. 24.) 850 w.

8946. The Effect of Self-Induction and Distributed Static Capacity in a Conductor. Frederick Bedell and Albert C. Crehor (E W–Dec. 24.) 800 w.

8948. On the Dissipation of the Electrical Energy of the Hertz Resonator. Nikola Tesla (E E N Y–Dec. 21.) 2000 w.

8949. Tables Showing Permissible Amperage and Depth of Winding for Cotton-Covered Wire. Walter S. Dix (E E N Y–Dec. 21.) 400 w.

8951. The Rope-Driven Electric Plant of the Racquet Club, New York City. Ill. (E E N Y–Dec. 21.) 400 w.

8952. A Differential Watt-Meter for Alternating Currents. Ill. A. E. Kennelly (E E N Y–Dec. 21.) 1300 w.

8953. A Simple Magnetic Detector. Ill. James Bowstead Williams (E E N Y–Dec. 21.) 500 w.

*8960. Sir David Salomon's Frequency-Raising Motor. Ill. (E E L–Dec. 9.) 1400 w.

*8962. Signalling and Speaking by Means of Electrical Currents without Wires. Sydney F. Walker (E E L—Dec. 9.) 1800 w.

8965. Electric Heating. Ill. P. K. Stern (E N Y–Dec. 21.) 3000 w.

9044. Factory Driving by Electricity. Ill. (W E–Dec. 24.) 1400 w.

†9047. The Inventor of the Lightning-Rod. Ill. Joseph J. Král (P S M–Jan.) 2000 w.

9094. Insulation Resistance of Cotton and Silk Covered Wires. Ill. T. T. P. Luquer (E E N Y–Dec. 28.) 2000 w.

9095. Entities, Magnitudes, Quantities and Units. E. Hospitalier (E E N Y–Dec. 28.) 900 w.

9097. Empirical Formulæ for H. B. Curves of Magnetization. Ill. Chas. E. Emery (E E N Y–Dec. 28.) 1800 w.

9099. Micanite and Its Application to Armature Insulation. Ill. Chas. W. Jefferson and Arthur H. S. Dyer (E E N Y–Dec. 28.) 4500 w.

9100. Steps in the Electrical Progress of 1892 (E R N Y–Dec. 31.) 2000 w.

9109. Captain A. DeKhotinsky. Ill. (E N Y–Dec. 28.) 1300 w.

9110. An Electrical El Dorado (E N Y–Dec. 28.) 600 w.

*9114. A Novel Amalgamated Plate for Battery Purposes (A M S–Nov. 12.) 1200 w.

9123. Generating Power at Coalfields and Transmitting It Electrically to Industrial Centres. Ill. (E W–Dec. 31.) 2000 w.

9124. A Handsome Switchboard. Ill. (E W–Dec. 31.) 600 w.

9125. Gold and Silver from the Sea.—A Proposed New Method for Coating Ship's Bottoms (Sc A–Dec. 31.) 700 w.

9131. Improved Electro-Extensometer. Ill. Chas. L. Heisler (A M–Dec. 29.) 600 w.

9167. Playing a Banjo by Electricity. Ill. (W E–Dec. 31.) 700 w.

*9209. The Late Dr. Von Siemens (E–Dec. 16.) 2700 w.

*9215. Historical Sketch of Storage Batteries with Discussion. C. F. Uberlacher (J A E S–Nov.) 8000 w.

*9278. Oscillations that Occur in the Charging of a Condenser. Ill. (E R L–Dec. 16.) 1000 w.

*9279. On the Velocity of Crookes's Cathode Stream. Lord Kelvin (E R L–Dec. 16.) 400 w.

*9303. Electrostatic Screening and Influence Machines. Ill. J. E. Taylor (E R L–Dec. 23.) 1100 w.

*9342. The Ewing High-Frequency Alternator and Parsons Steam Turbine. Nikola Tesla (El–Dec. 23.) 700 w.

9365. High vs. Low Frequency in Transformers. Louis T. Robinson (E W–Jan. 7.) 900 w.

9366. Experimental Determination of Electrical Oscillations. Ill. (E W–Jan. 7.) 500 w.

9367. Electrical Progress in Germany (E W–Jan. 7.) 1000 w.

9376. The Efficiency of Alternating Plants. Harris J. Ryan (E E N Y–Jan. 4.) 1000 w.

9378. The Commercial Success of Non-Arcing Metal Lightning Arresters. Alexander Jay Wurts (E E N Y–Jan. 4.) 800 w.

9394. Keller-Degenhardt Electric Vehicle. Ill. (W E–Jan. 7.) 300 w.

*9451. Advances in Electric Heating. Ill. W. R. Mason (E I–Jan.) 700 w.

9464. Electricity in St. Louis. Ill. Wm. H. Bryan (A S–Jan. 7.) 10,000 w.

*9488. The Profits of Electrical Engineering. Sydney F. Walker (E E L–Dec. 30.) 1400 w.

*9493. Electrical Needs of the Times. H. Franklin Watts (E L–Dec. 30.) 4500 w.

*9495. Errors of Observation in the Three-Voltmeter Method. Ill. A. Russell (El–Dec. 30.) 700 w.

*9497. The Deflection and Control of Galvanometers. E. T. Carter (El–Dec. 30.) 800 w.

*9498. The Objective Representation of Hertz's Researches on Electrical Radiation. Ill. L. Zehnder (El–Dec. 30.) 1200 w.

*9500. Explanation of the Magnetic Character of Certain Oxides. (E R L–Dec. 30.) 600 w.

*9501. Three-Phase Alternating Motors. Rankin Kennedy (E R L–Dec. 30.) 350 w.

9510. Electrification of Steam Jet. (E R N Y–Jan. 14.) 400 w.

9516. Rotation of the Magnetic Field. Chas. Steinmetz (E E N Y–Jan. 11.) 350 w.

9517. Central Station Economy. Francis B. Crocker (E E N Y–Jan. 11.) 600 w.

9534. The La Boiteaux Watch Demagnetizer. Ill. (E W–Jan. 14.) 650 w.

9579. Locating Trouble on Arc and Power Circuits in Central Station Work. C. O. Poole (W E–Jan. 14.) 4000 w.

*9609. Calcul d'un Petit Moteur Electrique de Dix Kilogrammètres. Ill. E. Meylan (El P–Dec. 3.) 3300 w.

*9610. Conjoncteur-Disjoncteur, Automatique, Système Stékelorum et Mangin. Ill. Em Dieudonné (El P–Dec. 3.) 400 w.

*9616. Etude sur un Champ Tournant Créé par une Source à Courants Continus. Ill. E. Yorel (El P–Dec. 17.) 2000 w.

*9619. Les Appareils Destinés à l'Etude des Propriétés Magnétiques du Fer. Ill. E. Meylan (El P–Dec. 24.) 2000 w.

*9620. Transmetteurs d'Ordres et Appareils Divers à Champ Magnétique Tournant. Ill. E. Yorel (El P–Dec. 24.) 2400 w.

*9622. Dynamos et Transformateurs O. Patin. Ill. F. Guilbert (Elec–Dec. 8.) 1600 w.

*9625. Electromoteur Déri. Ill. F. Guilbert (Elec–Dec. 15.) 2000 w.

*9628. Les Procédés Electriques de Désinfection. Ill. A. Rigaut (Elec–Dec. 15.) 700 w.

*9631. Perfectionnement aux Moteurs à Courants Déphasés. Ill. F. Guilbert (Elec–Dec. 22.) 1100 w.

*9632. Méthode de Mesure de Rendement des Transformateurs et Influence de la Fréquence. Ill. F. Guilbert (Elec–Dec. 29.) 2700 w.

*9639. Transport d'Energie Electrique à Grande Distance de Tivoli-Rome (Italie.) Ill. Max de Nansouty (G C–Dec. 10.) 2300 w.

Serials.

2784. Insulated Electric Conductors. Ill. James Bowstead Williams (E E N Y–Began March 16—15 parts to date—15 cents each).

5543. Light and Power Stations. Robb Mackie (E R N Y-Began July 23—12 parts to date—15 cts. each).

8339. Applications of Electricity to Agricultural Work. Ill. (E W-Began Dec. 3—5 parts to date—15 cts. each).

8571. Experimental Researches on Alternate Current Transformers. Ill. J. A. Fleming (El-Began Nov. 25—Ended Dec. 9—3 parts—30 cts. each).

8753. Iron-Rust Possessing Magnetic Properties. A. Livereidge (I-Began Dec. 2—Ended Dec. 23—2 parts—30 cts. each).

8905. Sparking at Commutators. Ill. F. M. Weymouth (El-Began Dec. 9—4 parts to date—30 cts. each).

8950. On the Exact Adjustment of Standards of Resistance and the Determination of Temperature Coefficients. E. G. Willyoung (E E N Y-Began Dec. 21—3 parts to date—15 cts. each).

8963. Economic Possibilities of the Generation of E. M. F. in the Coalfields, and Its Application to Industrial Centres. Ill. B. H. Thwaite (E E L-Began Dec. 9—Ended Dec. 30—4 parts—30 cts. each).

9233. Field Magnets. Ill. Gisbert Kapp (E E L-Began Dec. 16—Ended Dec. 30—3 parts—30 cts. each).

9373. New York's Electrical Subways. Ill. Wm. Maver, Jr. (E E N Y-Began Jan. 4.—2 parts to date—15 cts. each).

9374. Laminated or Divided Iron and Other Metallic Masses in Electromagnetic Apparatus. Thos. D. Lockwood (E E N Y-Began Jan. 4—2 parts to date—15 cts. each).

ELECTRIC LIGHTING.

8942. Advantages of Forcing Lamps at the Expense of Their Life. Ill. Carl Hering (E W-Dec. 24.) 1600 w.

8945. The Incandescent Lamp Patent Case; Full Text of the Opinion (E W-Dec. 24.) 3000 w.

8964. Christmas Electricity—Some Novelties in Electrical Science Which Are Being Presented to View This Year in New York. Ill. (E N Y-Dec. 21.) 3800 w.

8986. Electric Light Plant on Whaleback Steamers. Ill. (Sea-Dec. 22.) 200 w.

9061. Testing Arc Lamps. Ill. Jas. T. White (N M-Dec.) 400 w.

9096. Methods of Wiring a Building with Conduit. Ill. Paul C. Oscaugan (E E N Y-Dec. 28.) 800 w.

*9231. The Relative Merits of High and Low Tension Electric Distribution. Ill. Wm. Buchanan (E E L-Dec. 16.) 5000 w.

*9232. Scott's Electricity Meter Timed from a Central Position. Ill. (E E L-Dec. 16.) 900 w.

*9242. Price of Electric Supply. Letters from S. Flood-Page, Gisbert Kapp, and W. B. Sisling (El-Dec. 16.) 2500 w.

*9277. The Back Electromotive Force in the Arc. Ill. Camillo Olivetti (E R L-Dec. 16.) 1200 w.

*9307. Vestry of St. Pancras (E E L-Dec. 23.) 1800 w.

9327. History of the Lamp Case (E A-Jan. 7.) 1500 w.

*9341. A New Method of Preparing Filaments for Incandescent Lamps. Ill. (El-Dec. 23.) 350 w.

9362. The Incandescent Lamp Situation (E W-Jan. 7.) 2200 w.

9363. On Inert Gases in Incandescent Lamps. L. K. Böhm (E W-Jan. 7.) 1500 w.

9371. An Improved Electric Light Signaling Apparatus. Ill. (Sc A-Jan. 7.) 800 w.

9441. Electric Lighting at Topeka, Kansas. Lewis Kingman (A G L J-Jan. 9.) 1200 w.

*9452. Arc Meters and Arc Lamp Revenues. Albert Scheible (E I-Jan.) 1600 w.

*9503. Experiments on Alternate Current Arcs. Ill. E. Wilson (E R L-Dec. 30.) 700 w.

9539. Electric Lighting in Factories (M N-Jan. 1.) 600 w.

†9576. Electrical Recording Meters. Caryl D. Haskins (T A I E E-Jan.) 7500 w.

*9611. Etude sur la Consommation des Lampes à Incandescence. Ill. Ch. Haubtmann (El P-Dec. 10.) 2400 w.

*9613. Un Rhéostat de Lampe à Incandescence. Ill. P. Simon (El P-Dec. 10.) 400 w.

*9615. L'Eclairage Electrique de l'Avant-Port du Havre. Ill. Ch. Haubtmann (El P-Dec. 17.) 1800 w.

*9621. Interrupteurs à Distance. Ill. P. Simon (El P-Dec. 24.) 350 w.

*9633. L'Eclairage Electrique au Grand-Théâtre à Paris. Ill. P. Jannettaz (G C-Dec. 3.) 700 w.

Serials.

6709. Electric Light and Power. Arthur F. Guy (E E L-Began Sept. 9—8 parts to date—30 cts. each).

6889. Practical Electrical Units and Electric Light Calculations (M W-Began Sept. 16—Ended Dec. 16—6 parts—30 cts. each).

7186. Notes on the Fitting Up of Ships with the Electric Light. Alfred H. Gibbings (E L-Began Sept. 30—Ended Dec. 30—13 parts—30 cts. each).

9364. The Cologne Municipal Lighting Station. Ill. Clarence P. Feldmann (E W-Began Jan. 7—2 parts to date—15 cts. each).

9531. Suggestions for Metering Devices. Ill. S. D. Mott (E W-Began Jan. 14—1 part to date—15 cts.).

GAS ENGINEERING.

*8841. Gas Workers and Sunday Labor (J G L-Dec. 6.) 1800 w.

8851. Danger in the Use of Gas (Met W-Dec. 17.) 3000 w.

8867. A New Recording Pressure Gage for Extremely Low Ranges of Pressure. Ill. W. H. Bristol (A G L J-Dec. 19.) 500 w.

8873. A New Coke Process Invented by James C. Anderson (T-Dec. 15) 700 w.

*8917. The Transformation of Heat into Permanent Chemical Energy in the Production of Water Producer-Gas and Carbonic Acid Producer-Gas. A. Naumann (I–Dec. 9.) 1500 w.

*8928. The Quality of London Gas (C T J–Dec. 10.) 150 w.

*8959. Test of the Hygienic Open Gas Fire. Ill. B. H. Thwaite (I L–Dec. 9.) 500 w.

*8976. Tar Tank Explosions. Editorial (J G L–Dec. 13.) 2000 w.

*8977. Table to Facilitate the Correction of the Illuminating Power of Gas. Walter Grafton (J G L–Dec. 13.) 500 w.

*8978. Purification. Thos. Stenhouse (J G L–Dec. 13.) 800 w.

*8979. The Fatal Explosion at the Bradford Gas-Works (J G L–Dec. 13.) 1200 w.

9090. Rund's Automatic Steam Regulator for Gas Producers. Ill. (A G L J–Dec. 26.) 1200 w.

9091. The Gasholder Tanks of the Bay State Gas Company. Ill. A. P. Boller (A G L J–Dec. 26.) 1000 w.

*9239. The Fatal Explosion at the Bradford Gas Works (J G L–Dec. 20.) 3000 w.

9248. Hearne's Improved Center Seal. Ill. (A G L J–Jan. 2.) 2000 w.

9250. Gas and Electric Light (P A–Jan. 2.) 1200 w.

9252. Good Rules for Gasfitters (S P–Jan. 1.) 700 w.

*9354. The Theory of the Modern Gas-Engine. W. Norris (J G L–Dec. 27.) 800 w.

*9355. A Hundred Years of Gas Lighting. A. H. Bateman (J G L–Dec. 27.) 800 w.

9417. Tar Paving with Gas-Works Refuse. H. Tobey (E R–Jan. 7.) 1400 w.

9440. An Unpopular Subject, Popularly Treated. Frederic Egner (A G L J–Jan. 9.) 2800 w.

*9472. The Manufacture of Pure Naphthalene (I L–Dec. 30.) 1400 w.

*9603. La Production du Gaz de Chauffage et de l'Ammoniaque. A. Hennin (M I–Dec. 6.) 1400 w.

Serials.

8506. The Generation of Light from Coal Gas. V. B. Lewes (G W–Began Nov. 26.—Ended Dec. 17—4 parts—30 cts. each).

8834. Experimental Determination of the Heat Generated per Candle Power by Oil and Gas Lamps. D. S. Jacobus (P A–Began Dec. 15—2 parts to date—30 cts. each).

9491. On Sloping Retorts. Herr Hasse (G W–Began Dec. 31—1 part to date—30 cts.).

HYDRAULICS.

8852. Driven Wells at Lowell, Mass. (E R–Dec. 17.) 900 w.

8868. Protection of Exposed Water Mains Crossing Bridges, &c. Stephen E. Babcock (A G L J–Dec. 19.) 2700 w.

8913. Deep Bore-Holes (M N–Dec. 15.) 400 w.

*8985. The Mid-Sussex Waterworks, Balcombe. Ill. (Eng L–Dec. 9.) 60 w.

†9002. Bombay Irrigation, 1891-92 (I E–Nov. 19.) 900 w.

9015. The New Hydraulic Works at Niagara Falls. Ill. (R G–Dec. 23.) 2800 w.

9025. Pipe Computations. William Cox (E N–Dec. 22.) 350 w.

9034. The Flow of Water Over Wide-topped Dams. Ill. (E N–Dec. 22.) 400 w.

9041. Levee Protection, New Orleans. Ill. (E N–Dec. 22.) 300 w.

9080. The Milwaukee City Water-Works New Intake. Ill. (E R–Dec. 24.) 1200 w.

9160. Efficiency of Hydraulic Passenger Elevators.—Abstract of paper by H. B. Gale (R G–Dec. 30.) 1600 w.

9166. Specifications for Proposed Pumping Engines for the Waterworks of Osaka, Japan (E N–Dec. 29.) 700 w.

†9236. Notes on Victoria, B. C., and the Tai Tam Water-Works. R. R. B. (I E–Nov. 26.) 1800 w.

9275. Notes on a Problem in Water Power. John Richards (C E N–Jan.) 2000 w.

†9296. Note on the Formulæ Used by Mr. Thomas Box in his Book for the Discharge of Pipes (I Eng–Dec. 3.) 900 w.

*9319. Mid-Sussex Water-Works, Balcombe. Ill. (Eng L–Dec. 23.) 1300 w.

†9323. Nagpur Water-Works Extension. Ill. (I E–Dec. 3.) 500 w.

9398. The Artesian Wells of Oahn. C. H. Kluegel (E N–Jan. 5.) 600 w.

9444. Artesian Wells in South Dakota. Julian Ralph (M & B–Dec.) 700 w.

9465. The New Water-Works System of St. Louis. Ill. S. Bent Russell (A S–Jan. 7.) 3300 w.

9551. Piping Waukesha Water to Chicago (E N–Jan. 12.) 1000 w.

9581. Valuation of the Rights of Water Companies (E R–Jan. 14.) 750 w.

9583. The Arnhem Water-Works. Ill. (E R–Jan. 14.) 500 w.

*9635. Turbine et Pompe Horizontale. Ill. G. Foris (G C–Dec. 3.) 800 w.

*9640. Distribution d'Eau de Southampton et Installation pour l'Adoucissement des Eaux. Ill. T. C. H. (G C–Dec. 10.) 3300 w.

*9644. La Roue Pelton. Ill. W. J. Dubois and G. Harward (G C–Dec. 10.) 1200 w.

Serials.

8521. The Periyar Irrigation Project. Ill. A. S. Mackenzie (E–Began Nov. 25—Ended Dec. 9—3 parts—30 cts. each).

9582. Construction of the Niagara Falls Hydrauiic Plant. Ill. (E R–Began Jan. 14—1 part to date—15 cts.).

INDUSTRIAL CHEMISTRY.

8999. The Mathieson Alkali Works (M R-Dec. 23.) 800 w.

*9001. Bye-Products and Coke Ovens.—Abstract of paper by Chas. Dreyfut (G E M-Dec. 10.) 1000 w.

9054. Cost of Preparing Caustic Soda and Bleach by the Electrolysis of Salt (E M J-Dec. 24.) 400 w.

9169. The Chemical Combination of Water and Ammonia. Thos. Andreson (S E-Dec. 24.) 3000 w.

*9481. A Volatile Series of Metallic Compounds. C. F. Townsend (K-Jan. 2.) 2000 w.

9552. Ice-Making Plant (E N-jan. 12.) 350 w.

Serials.

8929. Expression of Oxidation Capacity as a Sixth Sense (Barker-Smith's Method.) (Inv-Began Dec. 10—Ended Dec. 17—2 parts—30 cts. each).

INDUSTRIAL SOCIOLOGY.

8836. Co-operation Between Employer and Employed in the Plumbing Business. J. J. Wade (D E-Dec. 15.) 1200 w.

*8957. The Relations of Capital and Labor in France. Editorial (I L-Dec. 9.) 1000 w.

†8995. What Immigrants Contribute to Industry. Geo. F. Parker (F-Jan.) 2000 w.

†8996. Alien Degradation of American Character. Sydney G. Fisher (F-Jan.) 2000 w.

†9048. The Rotation of the Farm. Appleton Morgan (P S M-Jan.) 2500 w.

*9214. Co-operative Industry. E. E. Hale (Cos-Jan.) 3000 w.

*9219. Capital and Labor. Editorial (I C T-Dec. 16.) 1500 w.

†9259. The Recent Commercial Policy of France. Emile Levasseur (J P E-Dec.) 10,000 w.

*9276. Capital and Labor. Editorial (E R L-Dec. 16.) 900 w.

*9321. Forced Wages. Editorial (Eng L-Dec. 23.) 2000 w.

†9369. Industrial Co-operation. David Dudley Field (N A R-Jan.) 1700 w.

†9370. Labor Organizations in Law. Oren B. Taft (N A R-Jan.) 1400 w.

†9389. Seligman's "Shifting and Incidence of Taxation." (An A A-Jan.) 6500 w.

*9470. The Apprentice Question. Editorial (I L-Dec. 30.) 1300 w.

*9553. Our New Industrial Policy. Editorial (S Ec-Jan.) 4000 w.

*9554. The Southern Social Problem. Kemper Bocock (S Ec-Jan.) 2700 w.

9591. Labor in Europe. (B J C-Jan. 14.) 1600 w.

*9638. Les Conditions du Travail en Italie. Max Duchanoy (G C-Dec. 3.) 2000 w.

LANDSCAPE ENGINEERING.

†9139. The Proposed Recession of the Yosemite Valley. (C M-Jan.) 1800 w.

9144. The Formation and Care of Lawns. (G & F-Dec. 28.) 1200 w.

MARINE ENGINEERING.

8833. Wages of Sailors. Editorial (Am S-Dec. 15.) 500 w.

8855. The Great Northern Steamships. Ill. (M R C-Dec. 15.) 900 w.

*8933. Calming the Sea with Oil. (M W-Dec. 9.) 500 w.

*8955. The Mercantile Shipowning of the World During the Last Seven Years. Ill. (I L-Dec. 9.) 1200 w.

8970. The New War Ship Brooklyn. Ill. (Sc A S-Dec. 24.) 800 w.

*8983. Note Upon Screw Propellers. Robert Mansel (Eng L-Dec. 9.) 800 w.

8988. A Floating Hotel. Ill. (Sea-Dec. 22.) 300 w.

*8991. Oil Fuel v. Coal for Steamers. M. I. N. A. (I & S-Dec. 10.) 500 w.

9036. The Cable Laying Steamer "Mackay-Bennett." (E N-Dec. 22.) 600 w.

9108. Electricity on Board Naval Vessels. Ill. (E N Y-Dec. 28.) 1400 w.

9147. The Old "Goliah." Ill. Frank P. Dow (Sea-Dec. 29.) 900 w.

9152. Pierce's Night Semaphore. (R.G-Dec. 30.) 500 w.

*9191. A Ship for Arctic Regions. (Eng L-Dec. 16.) 1000 w.

9198. The History of Ship Transportation. (E M J-Dec. 31.) 1000 w.

*9207. Stern-Wheel Steamer for the Argentine Government. Ill. (E-Dec. 16.) 800 w.

9213. Naval Steam Propulsion. (M G-Dec. 31.) 1200 w.

9260. War Vessels on the Lakes. (M R C-Dec. 29.) 1000 w.

9261. Palatial Ships for the Lakes. Ill. (M R C-Dec. 29.) 1500 w.

*9301. Shipbuilding and Marine Engineering in 1892. (E-Dec. 23.) 2700 w.

*9320. Screw Propellers and Influences on Their Action. Robert Mansel (Eng L-Dec. 23.) 4000 w.

*9337. The Vogelsang Propeller. (I-Dec. 23.) 1300 w.

9356. Lake Steel Steamers. Fred. A. Ballin (Sea-Jan. 5.) 2500 w.

9357. The American Inman Line (Sea-Jan. 5.) 500 w.

*9379. Ballasting the Ship "Brunel." Hugo P. Frear (I S F-Jan.) 2000 w.

9413. Repairing Steamship "Umbria's" Propeller Shaft. Ill. (E R-Jan. 7.) 1800 w.

9415. The Chignecto-Ship Railway. (E R-Jan. 7.) 500 w.

*9476. Additions to the Navy (E–Dec. 30.) 1500 w.

*9480. Marine Boiler Furnaces. Ill. D. B. Morison (S L–Jan.) 4500 w.

9587. One Warship's Engines. (M G–Jan. 14.) 450 w.

Serials.

9383. Vessels—Ancient and Modern. Percy W. Thompson (Am S–Began Jan. 5—2 parts to date—15 cts. each).

9542. Down the Ohio. Ill. Alex. R. Smith (Sea–Began Jan. 12—1 part to date—15 cts.).

MECHANICAL ENGINEERING.

*8815. Progress in Pneumatic Transmission. William Allen Smith (E Mag–Feb.) 3000 w.

*8816. Modern Uses of the Windmill. Ill. Robert H. Thurston (E Mag–Feb.) 3000 w.

8835. Some Applied Mechanics in 1892. (P A–Dec. 15.) 800 w.

*8850. On the Necessity of Efficient Lubrication. Geo. Skudder (M E & E J–Nov.) 5000 w.

*8863. The Strains in Lathe Beds. Ill. G. W. Bissell (S J E–Dec.) 2500 w.

8908. The Enormous Floating Derrick Used in Cramp and Son's Shipyard. Ill. (S V–Dec. 15.) 1000 w.

*8934. Buchanan's Brick and Tile-Making Machine. Ill. (M W–Dec. 9.) 1000 w.

8998. Some of Chicago's Great Manufacturing Plants. Ill. Clarence P. Day (M R–Dec. 23.) 1400 w.

9022. New Hoisting and Conveying System. Ill. (I T R–Dec. 22.) 700 w.

9032. Plate and Wire Gages. (E N–Dec. 22.) 1800 w.

9035. The Pelton Water Wheel and Atkins' Turbine Patents. Ill. (E N–Dec. 22.) 1300 w.

9084. Automatic Temperature Regulator of a Hot Water Supply. Ill. (E R–Dec. 24.) 700 w.

9181. Oils and Lubrication.—Some Facts Concerning Them (B J C–Dec. 31.) 1200 w.

9221. The True Principles of Lubrication. C. R. Tompkins (A S–Dec. 31.) 1200 w.

9381. Standard Keys. Ill. Chip (A M–Jan. 5.) 1800 w.

9538. Loose Pulleys. C. R. Tompkins (M N–Jan. 1.) 1300 w.

9590. Cooling a Hot Bearing. (B J C–Jan. 14.) 750 w.

*9634. Nouveau Moteur à Vapeur d'Ether Sulfurique, Système de Susini. Ill. Max de Nansouty and E. de Marchena (G C–Dec. 3.) 2700 w.

Serials.

8972. The Conradson Lathe. Ill. (Ir Age –Began Dec. 22—2 parts to date—15 cts. each).

METALLURGY.

8831. The Use of Asphaltum for Reservoir Linings. Abstract of paper by James D. Schuyler (E N–Dec. 15.) 700 w.

8842. How Foundry Men May Advance. John Birkinbine (I T R–Dec. 15.) 2400 w.

8854. The Characteristics of Metals (R & T –Dec.) 1500 w.

8856. Russell Process at the Marsac Mill vs. Amalgamation at the Ontario. W. G. Lamb (E M J–Dec. 17.) 800 w.

8871. Tests of Steel Wire Rods and Ropes. Ill. (A M & I W–Dec. 16.) 500 w.

8875. Southern Coke.—An Industry in the South to Rival Connellsville (T–Dec. 15.) 1300 w.

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9056. Experiments with the Cyanide Process. G. E. Kedzie (E M J–Dec. 24.) 700 w.

9057. Some Points in Mill Construction. Louis James, Jr. (E M J–Dec. 24.) 400 w.

9074. Method of Molding Glass, Metals, &c. Ill. R. M. Atwater (A M & I W–Dec. 23.) 1000 w.

9081. Steel Pipe Specifications (E R–Dec. 24.) 1200 w.

†9087. The Classification of Ore Deposits. J. F. Kemp (S M Q–Nov.) 2500 w.

†9088. Rapid Qualitative Examination of Mineral Substances. Alfred J. Moses and J. S. C. Wells (S M Q–Nov.) 2000 w.

†9089. The Volumetric Estimation of Zinc. Bertrand C. Hinman (S M Q–Nov.) 3000 w.

9112. The Metallurgical Slate of Two Decades (A S–Dec. 24.) 500 w.

*9113. The Clyde Smelting Works. Ill. (A M S–Nov. 12.) 800 w.

9143. Concentration (M S R–Dec. 22.) 1000 w.

9197. The Arrastra in the Metallurgy of Gold (E M J–Dec. 31.) 1000 w.

9200. Slag Pots Used in Lead Smelting. Ill. H. O. Hofman (E M J–Dec. 31.) 700 w.

9201. The Present Status of Stamp Milling. T. A. Rickard (E M J–Dec. 31.) 800 w.

9202. Bohm's Chlorination and Cyanide Plant. Ill. (E M J–Dec. 31.) 800 w.

*9220. Suggested Theories Explaining the Failure of Chilled Rolls, with Discussion. B. H. Thwaite (I & S–Dec. 17.) 2500 w.

*9267. Some English Steel Tests. J. A. H. (L E–Jan.) 1000 w.

*9269. In Krupp's Steel Works. J. A. H. (L E–Jan.) 900 w.

*9294. Report on the Chromium Steels of Mr. R. A. Hadfield. F. Osmond (I C T–Dec. 23.) 4000 w.

*9302. The Measurement of Furnace Temperatures by Means of Thermo-Couples (E R L–Dec. 23.) 600 w.

*9310. The Desulphurising of Iron and Steel by the Calcium Oxy-Chloride Process. E. H. Saniter (C G–Dec. 23.) 4800 w.

9358. Iron and Steel Industry.—The prize article on "What Industry Will Pay Best in the South." J. D. Imboden (T–Jan. 1.) 5500 w.

9359. Southern Furnaces.—The Errors in Locating, Building and Operating Them in the South (T–Jan. 1.) 1400 w.

9360. Southern Rolling Mills.—The Proper Conditions for Locating Rolling Mills in the South (T–Jan. 1.) 1800 w.

9361. Coke Making in the South. E. O. Nanhurst (T–Jan. 1.) 2700 w.

9390. Occurrence of Gogebic Ores. Ill. J. Parke Channing (I T R–Jan. 5.) 700 w.

9416. Actual Weights of Special Cast Iron Pipes. Ill. Maurice A. Vielé (E R–Jan. 7.) 500 w.

9433. The Treatment of Copper Ore at Bogoslowsk, Russia. Ill. M. Weiss (E M J–Jan. 7.) 1800 w.

9434. The Russell Process at the Blue Bird Mine, Montana. C. A. Hoyt (E M J–Jan. 7.) 900 w.

9442. Working Metals by Electricity. George D. Burton (B C–Jan. 7.) 1500 w.

*9477. The Finished Iron Trade—Past and Present. (E–Dec. 30.) 1500 w.

*9505. Irish Aluminous Iron Ores. Walter J. May (C G–Dec. 30.) 1150 w.

9525. Malleable Iron Castings. S. Boland (A M–Jan. 12.) 3500 w.

9561. The Russell Process at Las Yedras, Sinaloa, Mexico. R. F. Letts (E M J–Jan. 14.) 1300 w.

*9607. Préparation du Chrome Métallique par Electrolyse. Em. Placet (M I–Dec. 20.) 400 w.

*9608. Dosage du Manganèse dans les Produits Sidérurgiques. M. Campradon (M I–Dec. 20.) 2000 w.

*9651. Résultats Comparés d'Acier-Nickel et d'Acier Fabriqués aux Etats-Unis. Jules Garnier (G C–Dec. 24.) 500 w.

Serials.

7680. The Freiburg Works, Germany (A M S–Began Sept. 24—6 parts to date—30 cts. each).

7854. The Concentration of Iron Ores. Walter J. May (Inv–Began Oct. 29—Ended Dec. 31—8 parts—30 cts. each).

8289. The Iron Industry of the British Colonies.—Its Position and Prospects (C G–Began Nov. 18—7 parts to date—30 cts. each).

8807. Tin Plate. Ill. (Ir Age–Began Dec. 15—5 parts to date—15 cts. each).

9137. Some Chemical and Physical Properties of Steel and Alloy Steels. John W. Langley (Ir Age–Began Dec. 29—2 parts to date—15 cts. each).

9380. Keep's Test for Cast Iron. Ill. W. J. Keep (A M–Began Jan. 5—2 parts to date—15 cts. each).

9435. The Action of Sulphuric and Nitric Acids on Lead of Different Degrees of Purity. Geo. Lunge (E M J–Began Jan. 7—2 parts to date—15 cts. each).

9459. The Manufacture of Coke. John Fulton (C E–Began Jan.—1 part to date—30 cts.).

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*8861. Coast Defence (S J E–Dec.) 600 w.

8967. Commodore Melville's Report (A M–Dec. 22.) 1200 w.

9043. Smokeless Powder and Magazine Rifles. L. G. Duff Grant (A & N J–Dec. 24.) 14,000 w.

9128. The New Army Magazine Rifle. Ill. (Sc A–Dec. 31.) 2000 w.

*9190. Notes on the Recent Russian Plate Trials. Ill. (Eng L–Dec. 16.) 1200 w.

9281. Krupp vs. Canet. A Controversy by a German Artillerist and a French Artillerist (J U S A–Oct.) 3800 w. (*Price $1 or 7 coupons.*)

*9289. The New Mannlicher Rifle (R A E J–Jan.) 700 w.

*9300. Armstrong Quick-Firing Guns (E–Dec. 23.) 800 w.

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†9345. The Knapsack. Wm. Quinton (J M S I–Jan.) 1400 w.

†9346. Musketry Training, and its Value in War. James Parker (J M S I–Jan.) 8000 w.

†9348. Infantry in Combat. Ill. Trans. by Joseph B. Batchelor (J M S I–Jan.) 6000 w.

†9350. Prof. Hebler on the Best Possible Form of Bullet (J M S I–Jan.) 600 w.

9403. Military Railway Corps in Europe (E N–Jan. 5.) 1100 w.

9411. Nickel for American Armor Plates (B I S–Jan. 4.) 1700 w.

9424. A Great Gun. Astonishing Results at a Test of the Wire Wound Rifle (B J C–Jan. 7.) 500 w.

9443. American Armor Plates (M & B–Dec.) 900 w.

*9479. Butt Connections of the Shell-Plating of Large Vessels. Ill. Herr Middendorf (E–Dec. 30.) 2000 w.

9545. Advance in American Ordnance (E N–Jan. 12.) 1200 w.

Serials.

7660. Abstract of Munroe's Lectures on Chemistry and Explosives. J. P. Farley (J M S I–Began Nov.—Ended Jan.—2 parts—45 cts. each).

8241. Assault and Battery. Ill. A. Ewbank (I E–Began Oct. 22—5 parts to date—45 cts. each).

9336. Navigable War Balloons. H. Hutchins (Inv–Began Dec. 24—Ended Dec. 31—2 parts —30 cts. each).

9347. Notes of Lectures on Artillery and Coast Defense. A. C. Hansard (J M S I–Began Jan.—1 part to date—45 cts. each).

MINING.

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8832. To Determine What Is Mineral Land. J. E. Bell (M S P–Dec. 10.) 1000 w.

8857. The Chemistry of Gossau. Stephen H. Emmens (E M J–Dec. 17.) 2500 w.

8858. Alabama Banxite. Henry McCalley (E M J–Dec. 17.) 800 w.

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8874. Exhaustion of British Coal. Editorial (T–Dec. 15.) 900 w.

*8920. An Old Work on Coal Mining (C G–Dec. 9.) 850 w.

*8923. Danger from a Relighting Safety Lamp. R. Grey (C G–Dec. 9.) 1100 w.

*8924. The Utilization of Waste Water at Mines. Walter J. May (C G–Dec. 9.) 1000 w.

*8926. The Mineral Industries of Italy (E–Dec. 9.) 1500 w.

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*8992. The South Wales Coal Crisis (I & S–Dec. 10.) 1800 w.

*8993. Safety Lamps (I & S–Dec. 10.) 600 w.

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*9119. South African Mining. S. L. Bensusan (A M S–Nov. 26.) 1200 w.

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*9604. Transformation de la Lampe de Sûreté Ordinaire en Indicateur Très Sensible de Grison. (M I-Dec. 13.) 2000 w.

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*9643. Table à Laver du Maros. Traitement des roches pauvres pour pyrites riches. Ill. Effère (G C-Dec. 10.) 2500 w.

*9646. Découverte de Terrains Pétrolifères dans la Limagne d'Auvergne. Ill. P. Dubreuil and J. de Clercy (G C-Dec. 17.) 3000 w.

*9650. Appareil de Lavage des Sables Métallifères. Ill. Effère (G C-Dec. 24.) 2000 w.

†9653. Les Ventilateurs de Mines. Rapport de la Commission Institutée, pour l'Etude des Ventilateurs, par la Direction de l'Industrie de la Société Générale pour Favoriser l'Industrie Nationale. Ill. Henri Mativa, Emile Desvachez, Isaac Isaac, and Nestor Evrard (R U M-Nov.) 10,000 w.

Serials.

8359. The Maryborough Mines. (Vic.) (A M S-Began Oct. 22—3 parts to date—30 cts. each).

8608. L'Electricité dans les Mines. Ill. (Elec-Began Nov. 17—5 parts to date—30 cts. each).

8910. The Engineer and Modern Mining Machinery. Ill. E. Hedburg (S E-Began Dec. 17—1 part to date—15 cts.).

8922. Determination of the Quantities of Firedamp Given Out in Underground Workings. M. Léon Poussigue (C G-Began Dec. 9—3 parts to date—30 cts. each).

9003. Diamonds in India. A. Rechauffée. Dr. W. King (I E-Began Nov. 19—2 parts to date—45 cts. each).

9117. The Dalmorton Gold Field. (N. S. W.) (A M S-Began Nov. 26—1 part to date—30 cts.).

9136. The Mesabi Iron Range. Horace V. Winchell (Ir Age-Began Dec. 29—3 parts to date—15 cts. each).

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*8982. English v. American Locomotives. Letters from W. B. Thompson and Progress (Eng L–Dec. 9.) 2000 w.

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9059. An International Railway and Steamship Route. F. E. Sickels (A & B–Dec. 24.) 1500 w.

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9262. The Pounding at Rail Joints. Editorial (E & R–Dec.) 1900 w.

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*9264. The Best Shop I Saw in England. Ill. J. A. H. (L E–Jan.) 2500 w.

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9272. Westinghouse Electric Railway Apparatus. Ill. (S R G–Jan. 2.) 2200 w.

†9280. Nationalization of Railroads. Rabbi Solomon Schindler (A–Jan.) 1600 w.

*9282. Union Pacific Fast Mail Locomotive. Ill. (N C B–Jan.) 1200 w.

*9283. Action of the Water Brake. Ill. M. E. Wells (N C B–Jan.) 3000 w.

*9284. Feed Water for Locomotives. Wm. McIntosh (N C B–Jan.) 1500 w.

*9285. Reducing the Oil Consumption of Locomotives. T. W. Gentry (N C B–Jan.) 1200 w.

*9286. The Siberian Railroad (R A E J–Jan.) 900 w.

*9318. The Atmospheric Railway (Eng L–Dec. 23.) 2600 w.

*9322. High Railway Speeds in France. Ill. (Eng L–Dec. 23.) 450 w.

9326. Sabold's Return Ground System for Electric Railways. Ill. (E A–Jan. 7.) 500 w.

9328. Philadelphia's First Electric Railway. Ill. (E N Y–Jan. 4.) 700 w.

9377. Maximum Speed on Electric Railways. Chas. Steinmetz (E E N Y–Jan. 4.) 550 w.

†9385. Railway Signaling as Applied to Large Installations. Ill. John P. O'Donnell (T C E–Nov.) 4800 w.

†9388. Discussion on Motive Power for Street Railways. E. N. Kirk Talcott, H. W. Brinckerhoff, Robert L. Harris, Arthur Y. Dodge, C. E. Emery, W. H. Breithaupt, E. E. R. Tratman and Alfred F. Sears (T C E–Nov.) 6000 w.

9404. British Canal and Railroad Competition. J. S. Jeans (R G–Jan. 6.) 2000 w.

9405. Pacific Extension of the Great Northern. Ill. (R G–Jan. 6.) 1600 w.

9406. The Ammonia Railroad Motor. Ill. (R G–Jan. 6.) 1200 w.

9407. The New Freight Rates in England. W. M. Acworth (R G–Jan. 6.) 1800 w.

9409. Rapid Transit in New York. Editorial (R G–Jan. 6.) 1600 w.

9410. European and American Car Service (R G–Jan. 6.) 1300 w.

9447. A New Steel Tank Car. Ill. (R R–Jan. 7.) 900 w.

9448. Block Signal System of the C. & N. P. R. R. Ill. (R R–Jan. 7.) 600 w.

9449. The Apportionment of Traffic Among Competing Railroads. Joseph Nimms, Jr. (R R–Jan. 7.) 3000 w.

9453. Railroading in California. Richard P. Morgan (R A–Jan. 6.) 5000 w.

9454. The Westinghouse Quick Action Air Brake in Elevated Railroad Practice. Ill. (R A–Jan. 6.) 1500 w.

9466. The Manufacture of Street Cars in St. Louis (A S–Jan. 7.) 700 w.

*9482. The New Railway Rates and the Metal and Engineering Trades (Eng L–Dec. 30.) 2000 w.

*9483. Some Early Railway Brakes. Ill. (Eng L–Dec. 30.) 900 w.

9490. Standard Tender.—Louisville and Nashville Railroad. Ill. (R M M–Jan.) 700 w.

*9499. The Belgian Electric Railway.—Interview with M. P. Vandenkerchove (E R L–Dec. 30.) 800 w.

*9502. Automatic Railway Signaling. Ill. (E R L–Dec. 30.) 500 w.

9518. The Electric Mail Car in St. Louis and Other Cities. Ill. (E E N Y–Jan. 11.) 700 w.

9528. Traveling in America Sixty Years Ago (Sc A–Jan. 14.) 1200 w.

9529. Rapid Transit (E W–Jan. 14.) 3000 w.

9530. The Rock Creek Electric Railway, Washington, D. C. Ill. F. G. Bolles (E W–Jan. 14.) 4000 w.

9536. A Plan for Locomotive Building Shops. Ill. (Ir Age–Jan. 12.) 2500 w.

9550. Continuous Rails for Railways. Ill. (E N–Jan. 12.) 2500 w.

9567. Hall Automatic Block Signals on the Chicago and Northwestern. Ill. (R G–Jan. 13.) 1800 w.

9568. Wilson's Block Signal Circuit. Ill. (R G–Jan. 13.) 700 w.

9569. A Few Notes on European Railroads. J. P. Pattinson (R G–Jan. 13.) 2400 w.

9570. Water on the Southern Pacific Railroad. Ill. (R G–Jan. 13.) 700 w.

9572. Railroad Abbreviations (R G–Jan. 13.) 1800 w.

Serials.

8458. Locomotive Running Among the Bushwhackers. Old Soldier (L E–Began Dec.—2 parts to date—30 cts. each).

8631. Tramways Electriques. Ill. Gérard Lavergne (G C–Began Nov. 12—Ended Nov. 19—2 parts—30 cts. each).

8782. Systèmes Spéciaux de Traction. Emile Dieudonné (El P–Began Nov. 26—3 parts to date—30 cts. each).

8845. Passenger Traffic in Great Cities.—From an Address by J. James R. Croes (R G–Began Dec. 16—Ended Dec. 30—2 parts—15 cts. each).

8958. Thwaite's Electric Power Transmission Scheme. Ill. (I L–Began Dec. 9—Ended Dec. 30—4 parts—30 cents each).

9205. The St. Gall and Gais Mountain Road Railway. Ill. C. S. Du Riche Preller (E–Began Dec. 16—Ended Dec. 30—2 parts—30 cents each).

9254. Railway Management. Horace Cope. (R R–Began Dec. 31—1 part to date—15 cts).

9274. Instructions for the Management of Electric Cars. Ill. (C E N–Began Jan.—1 part to date—15 cts.)

9492. The Resistance of Railway Curves (M W–Began Dec. 30—1 part to date—15 cts).

9629. Le Traction Electrique. Ill. (Elec–Began Dec. 22—2 parts to date—30 cts. each).

SANITARY ENGINEERING.

8826. The Lawrence Experiments on the Purification of Sewage in 1890 and 1891 (E N–Dec. 15.) 1200 w.

8886. Stable Drainage. Ill. (A A–Dec. 17.) 400 w.

9031. Water Supply and Typhoid Fever in the Valley of the Tees, Yorkshire, England (E N–Dec. 22.) 500 w.

9042. Cost of Brick and Pipe Sewers at Toronto, Ont. (E N–Dec. 22.) 500 w.

9082. The Wilmington, Del., Sewerage System. Ill. (E R–Dec. 24.) 600 w.

9162. The Dortmund Sewage Disposal Works. Ill. (E R–Dec. 31.) 900 w.

9163. Novel Features in a Boston Bathroom. Ill. (E R–Dec. 31.) 700 w.

*9187. Sanitary Appliances at the Hornsey Museum (Eng L–Dec. 16.) 900 w.

9224. The Sewage of Paris. George S. Lespinasse (F W–Dec. 31.) 1200 w.

*9253. Water-Supply in Relation to Public Health. G. H. Gemmell (S R–Dec. 15.) 2000 w.

*9298. Ventilation. Editorial (E–Dec. 23.) 2500 w.

9332. Hot-Water Heating and Ventilation (C & B–Jan.) 3000 w.

9382. A Process for Preventing the Pollution of Rivers, and Rendering Organic Matter Harmless (P M–Jan. 5.) 650 w.

9402. The Lawrence Experiments on the Purification of Water in 1890 and 1891 (E N–Jan. 5.) 1000 w.

*9641. De la Pollution des Rivières et de leur Purification. Ch. Heinrich-Chéret (G C–Dec. 10.) 1400 w.

Serials.

5358. Sewage Purification in America (E N–Began July 14—18 parts to date—15 cts. each).

8700. Drainage Blunders. Ill. Albert L. Webster (E R–Began Dec. 10—3 parts to date—15 cts. each).

STEAM ENGINEERING.

8853. The Broken Engine Shaft at the Wamsutta Mills (E R–Dec. 17.) 850 w.

8907. Fuel Economy: How It May Be Gained and Prevented. Ill. Stephen Christie (S V–Dec. 15.) 800 w.

8909. The Work of Chimneys. Jas. Keenan (S E–Dec. 17.) 1200 w.

8974. The Worthington Feed Water Heater. Ill. (Ir Age–Dec. 22.) 1500 w.

*8984. The Mystery of Steam. Editorial (Eng L–Dec. 9.) 2800 w.

9019. Smoke in Chicago (R G–Dec. 23.) 700 w.

9023. A New High-Duty Pumping Engine of the Boston Water-Works. Ill. (E N–Dec 22.) 4000 w.

9033. The Relative Economy of High-Duty Pumping Engines, with Letters on the Subject (E N–Dec. 22.) 6500 w.

9051. An English Cotton-Mill Engine.—Peculiar Arrangement of the Connecting Rods. Ill. (B J C–Dec. 24.) 1000 w.

9127. On Smoke Prevention (Sc A–Dec. 31.) 1300 w.

9132. Smoke Prevention. W. H. Odell (A M–Dec. 23.) 1400 w.

9170. Determining the Temperature. Frank J. Roth (S E–Dec. 24.) 1200 w.

9179. How the Strength of a Boiler is Figured. (B J C–Dec. 31.) 1000 w.

9180. Some Engine Improvements. Less Work on the Governor and an Improved Cylinder. (B J C–Dec. 31.) 1000 w.

9182. Boiler Room Wastes (B J C–Dec. 31.) 1000 w.

*9218. The Arrangement of Condenser Tubes. Ill. (M W–Dec. 16.) 550 w.

9251. A Great Steam Heating Plant. Ill. (S P–Jan. 1.) 1300 w.

9273. An Early Comparison Between Steam Power and Electro-Magnetic Power. P. H. Van der Weyde (E R N Y–Jan. 7.) 1600 w.

*9287. The Horse-Power of a Locomotive. Ill. (R A E J–Jan.) 1700 w.

*9288. Cylinder Condensation and Steam-Engine Economy. W. C. Unwin (R A E J–Jan.) 1800 w.

9293. Large Steam Cylinders and their Liners. Ill. (Ir Age–Jan. 5.) 800 w.

*9299. The Thornycroft Boiler. Editorial (E–Dec. 23.) 1600 w.

9352. Wetting Coal. (S E–Dec. 31.) 450 w.

9353. The Engineer's License Law of Chicago. (S E–Dec. 31.) 2000 w.

9391. Standardization of the Steam Engine Indicator. Ill. F. H. Conant (P S–Jan.) 1800 w.

9392. Theisen's Evaporative Surface Condenser. Ill. (P S–Jan.) 800 w.

9408. Feed Waters and Boiler Incrustation. Harry Silvester (R G–Jan. 6.) 3300 w.

9419. The Folly of High Pressures for Steam Power Plants. (E R–Jan. 7.) 700 w.

9425. A Smoke Consumer. A Simple and Inexpensive Device. Ill. (B J C–Jan. 7.) 600 w.

*9429. A Graphic Representation of the

Distribution of Heat in Steam Engines. Ill. (E M-Jan.) 1000 w.

*9475. Boiler Explosions and the Board of Trade. Editorial (E-Dec. 30.) 2000 w.

9544. Recent Developments in Steam Turbines. Ill. (E N-Jan 12.) 3500 w.

9547. Tests of the Parsons' Steam Turbine. Editorial (E N-Jan. 12.) 1000 w.

9586. Separation and Utilization of Oil from Engine Exhausts. Ill. (E R-Jan. 14.) 1000 w.

Serials.

8561. An Analysis of the Shaft Governor. Ill. F. M. Rites (E M-Began Dec.—2 parts to date—30 cts. each).

8769. Etude sur les Explosions de Générateurs de Vapeur. A. Witz (M I-Began Nov. 29.—Ended Dec. 20—4 parts—30 cts. each).

8837. Steam vs. Hot Water for Greenhouse Heating. Ill. L. R. Teft (D E-Began Dec. 15—1 part to date—15 cts.).

8919. Combustion of Coal and Prevention of Smoke. Ill. J. R. Fothergill (P Eng-Began Dec. 9—2 parts to date—30 cts. each).

8956. Research Committee on the Value of the Steam Jacket. (I L-Began Dec. 9—4 parts to date—30 cts. each).

9111. Old Time and Modern Piston Packing. G. Marion White (Eng-Began Dec. 24—2 parts to date—15 cts. each).

9427. Notes on the Steam Injector. Strickland L. Kneass (E M-Began Jan.—1 part to date—30 cts.).

TELEPHONY AND TELEGRAPHY.

8939. The Telephone in Sweden. Ill. Hjalmar Van Kohler (E R N Y-Dec. 24.) 1000 w.

9016. A Pacific Cable. (R G-Dec. 23.) 500 w.

9101. Novel Telephone System. Ill. (E R N Y-Dec. 31.) 400 w.

*9478. Submarine Telegraph Enterprise. (E-Dec. 30) 1400 w.

9511. Long Distance Telephony and Telegraphy. Ill. (E R N Y-Jan. 14.) 800 w.

9578. Single Wire, Non-Insulated Telephony. Ill. (W E-Jan. 14.) 1200 w.

*9614. Les Appareils pour la Mesure des Résistances d'Isolation. Boite d'Essai de Lignes de M Desruelles. Ill. E. Meylan (El P-Dec. 17) 1900 w.

*9618. Les Nouveaux Cables Téléphoniques de la Maison Felten et Guilleaume. Ill. J. A. Montpellier (El P-Dec. 24.) 900 w.

*9630. Le Bitéléphone Mercadier. Ill. (Elec-Dec. 22.) 1900 w.

Serials.

6515. Notes on Submarine Cable Work. Ill. H. D. Wilkinson (El-Began Sept. 2—7 parts to date—30 cts. each).

8607. L'Industrie Française des Cables Sous-Marins (Elec-Began Nov. 10—Ended Dec. 8—4 parts—30 cts. each).

9649. Statisque des Téléphones. Ill. V. Turquan (G C-Began Dec. 24—1 part to date—30 cts.).

MISCELLANEOUS.

*8820. The World's Fair and Industrial Art. Alfred T. Goshorn (E Mag-Feb.) 3000 w.

*8821. The Timber Problem in the South. Charles Mohr (E Mag-Feb.) 3000 w.

8840. The Nicaragua Canal and American Commerce. John L. Williams (M R-Dec. 16.) 2700 w.

8843. The Professional Status of the Engineer in America. Foster Crowell (R G-Dec. 16.) 2300 w.

*8860. The Accomplished Man as Engineer—Abstract of Address by Mr. Oberlin Smith (S J E-Dec.) 2000 w.

*8870. Escape from Buildings in Case of Fire. Chas. Baillairge (Can A-Dec.) 2600 w.

*8897. Testing Fuels by Incineration (A J R A-Dec.) 1500 w.

*8902. The Peary Relief Expedition. Ill. Angelo Heilprin (Sc M-Jan.) 10,000 w.

*8918. Asbestos (P Eng-Dec. 9.) 1400 w.

*8932. Navigable Balloons. W. N. Hutchinson (Inv-Dec. 10.) 500 w.

8941. Breathing Well in Logan County, Kansas. J. T. Willard (Sc-Dec. 16.) 800 w.

†8947. The Transformation of Energy: Joule's Discovery. V. E. Johnson (W R-Dec.) 5000 w.

8975. The Roberts-Burgess Regenerative Pottery Kiln. Ill. (Ir Age-Dec. 22.) 3000 w.

*8990. Manufacture of Red Paint from Pig Cinder (Pl D-Dec. 1.) 600 w.

†8994. Necessity for a National Quarantine. E. O. Shakespeare (F-Jan.) 5000 w.

†8997. The Wealth and Business Relations of the West. C. S. Gleed (F-Jan.) 5500 w.

9006. Art in Its Relation to Industry. L. Alma-Tadema (A B M-Dec.) 450 w.

9028. Measurement of the Velocity of Air in Pipes. Bryan Dankin, Jr. (E N-Dec. 22.) 1200 w.

†9045. Quarantine and the United States Marine Hospital Service. A. N. Bell (San-Dec.) 6500 w.

†9049. Profits of Legitimate Business Not Too Large. P. F. Hallock (P S M-Jan.) 1000 w.

†9050. Good Roads and Country Life (P S M-Jan.) 600 w.

*9072. Commerce of the Great Lakes (S-Dec.) 900 w.

9075. Some Average Rates of Lake Freights (M R C-Dec. 22.) 150 w.

9085. Public Hot Water Fountains in Paris. Ill. (E R-Dec. 24.) 600 w.

9107. How Can the Present Status of the Engineering Profession Be Improved? H. F. J. Porter (R R-Dec. 24.) 3000 w.

9120. Confusion in Weights and Measures. Wm. P. Mason (Sc-Dec. 23.) 900 w.

†9178. Annual Report of the Trustees of the New York and Brooklyn Bridge. (S R J-Jan.) 1000 w.

*9192. Curious Photographic Phenomena and Their Application to Engraving. (Eng L-Dec. 16.) 3700 w.

*9314. The Utilization of Niagara.—Abstract of paper by George Forbes. (C G-Dec. 23) 3800 w.

†9343. Hot-Air Balloons. Ill. E. L. Zalinski (J M S I-Jan.) 2200 w.

†9368. Shall Immigration be Suspended? W. E. Chandler (N A R-Jan.) 3000 w.

9396. Error Resulting from the Use of the Jolly Air Thermometer. Ill. R. C. Carpenter (E N-Jan. 5.) 1400 w.

9399. Theses in Engineering Schools. Editorial (E N-Jan. 5.) 1000 w.

9414. Creation of the Columbian Exposition Grounds and Buildings. (E R-Jan. 7.) 4500 w.

9589. Measuring Air.—Means Employed for Testing Its Supply and Purity. (B J C-Jan. 14.) 1200 w.

9594. The Flash Point and Heat of Burning Mineral Oil. D. R. Stewart (A. M & I W—Jan. 13.) 1200 w.

*9647. Le Progrès Mesuré par l'Art de l'Ingénieur. Max de Nansouty (G C-Dec. 17.) 2200 w.

Serials.

2845. The Engineering Schools of the United States (E N-Began March 19—37 parts to date—15 cts. each).

8407. Professional Ethics and Etiquette (E R-Began Dec. 3—5 parts to date—15 cts. each).

8637. La Prévention des Accidents du Travail dans les Usines et les Manufactures. Ill. Félix Jottrand (R U M-Began Oct.—Ended Nov.—2 parts—45 cts. each).

8644. Commerce on the Lakes. S. G. Brock (Sea-Began Dec. 8—4 parts to date—15 cts. each.)

8931. Value of Inventions to Civilization. (Inv-Began Dec 10—3 parts to date—30 cts each).

9073. Destructive and Conservative Distillations of Mineral Oils. Ill. J. Laing (A M & I W-Began Dec. 23—2 parts to date—15 cts. each).

9329. Utilizing the Forces of Nature. Nelson W. Perry (E N Y-Began Jan. 4—2 parts to date—15 cts. each).

9401. World's Columbian Exposition (E N-Began Jan. 5—1 part to date—15 cts.).

9485. The Errors of Experts. Jos. Williams (Inv-Began Dec. 31—1 part to date—30 cts.).

9519. Municipal Equipment and Engineering of Paris. Jas. W. Howard (P-Began Jan. —1 part to date—15 cts.).

9580. Loss of Heat from Range Boilers (Met W-Began Jan. 14—1 part to date—15 cts.).

NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Apthorp, H.=Two-Cent Railroad Fare and Other Railroad Legislation in Ohio. Akron, O.: Werner Ptg. and Litho. Co. [8vo, paper, 42 p., 10c.]

Ainsley's Engineer's Manual of the Local Marine Board Examinations. New York: Spon. [8vo, cloth, 2 vols., 721 p., $5]

Bel, J. M.=Les Mines d'Or du Transvaal. Paris: Libr. Chaix. [8vo, paper, 14 p.]

Boyd, R. Nelson=Coal-Pits and Pitmen. A short history of the coal trade and the legislation affecting it. New York: Macmillan. [12mo, cloth, 264 p., $1.]

Booth, H J.=A Treatise on the Law of Street Railways, Embracing Surface, Sub-Surface, and Elevated Roads, Whether Operated by Animal Power, Electricity, Cable, or Steam Motor. Philadelphia: T. & J. W. Johnson & Co. [8vo, sheep, 766 p., $6.]

Burn, Rob. Scott.=The Carpenter and Joiner. New York: Ward, Lock, Bowden & Co. [8vo, cloth, 280 p., $2]

Burn, Rob. Scott.=The Student's Introduction to Mechanics. New York: Ward, Lock, Bowden & Co. [8vo, cloth, 544 p., $2.]

Chesneau, G.=Rapport sur l'Industrie et le Commerce des Huiles Minérales en Allemagne et en Belgique. Paris: Impr. Nationale. [4to, paper, 35 p.]

Courmes, L.=Observations Magnétiques Faites Pendant la Campagne du Croiseur "le Dubourdien." Paris: Impr. Nationale. [8vo, paper, 54 p.]

Croneau, A.=Canon, Torpilles, et Cuirasse: Leur Installation à Bord des Bâtiments de Combat. Paris: Gauthier-Villars et fils. [16mo, paper, 203 p., 2*fr.* 50*c.*]

Cabinetmaker, The. By various writers. New York: Ward, Lock, Bowden & Co. [8vo, cloth, 178 p., $2]

Colyer, F.=Treatise on the Modern Sanitary Appliances for Healthy Residences and Public Buildings, for the Use of Students. New York: Spon. [8vo, cloth, 113 p., $2.]

Cleveland Twist Drill Co=Catalogue of Increase Twist Drills, 1893. Cleveland. [8vo, 50p.]

Devaux, L.=Etude de Droit Industriel. Protection internationale des inventions brevetées. Paris: Girard et Brière. [8vo, paper, 164 p.]

Dufourmantelle, M.=Code Manuel de Droit Industriel. Comprenant l'étude des lois et de la jurisprudence françaises sur la législation ouvrière et la propriété industrielle, avec l'exposé des principales législations étrangères Paris: Girard et Brière. [18mo, paper, 293 p., 3 *fr.*]

Dudebout.=Appareils d'Essai à Froid et à Chaud des Moteurs à Vapeur. Paris: Gauthier-Villars et fils. [16mo, paper, 199 p., 2 *fr.* 50*c.*]